

# The effect of non-powered, self-initiated mobility on the engagement of young children with severe mobility impairment

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‘After climbing a great hill, one only finds that there are many more hills to climb.’

**Nelson Mandela**

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**ABSTRACT**

Engagement is the active involvement in experiences which allows for development. For children with severe mobility impairments however, challenges arise in accessing experience which can lead to learned helplessness. Due to these challenges powered mobility has been suggested as a mechanism for the provision of self-initiated access to experiences. However, powered mobility is out of reach of the majority of children with disabilities in South Africa hence a non-powered alternative has been sought. This study sought to determine the effect of non-powered, self-initiated mobility on the engagement of young children, with severe mobility impairment, in play. A multiple probe design across participants was used. Four participants, aged 2 years 10 months to 6 years 9 months with severe mobility impairment (Gross Motor Function Classification Scale (GMFCS) level V) underwent a minimum of 5 baseline sessions, followed by 8 intervention sessions. Engagement was measured during each session using the Individual Child Engagement Record –Revised (ICER-R). The data was analysed using visual graphic and statistical analysis. All participants demonstrated an improvement in engagement in play with the introduction of non-powered, self-initiated mobility. A reciprocal deterioration in non-engagement was also recorded. A decrease in engagement in play at the start of intervention was attributed to the focus of engagement being on mobility skills as the device was introduced but this reverted as the participants spent more time on the mobility device. Functional abilities were identified as having a greater role in engagement than age. The introduction of non-powered, self-initiated mobility correlated with the improvement of engagement of young children with severe motor impairment. Non-powered, self-initiated mobility is a viable, cost effective mechanism for mobility at a young age.

**KEYWORDS:** Cerebral Palsy (CP), engagement, non-powered mobility, severe motor impairment, young children

## **CHAPTER 1: PROBLEM STATEMENT AND RATIONALE**

### **1.1. Introduction**

This chapter serves as an orientation to this study. It provides the background and purpose of the research and explains terminology and abbreviations commonly used in this study. An outline of each of the chapters is subsequently provided.

### **1.2. Problem statement**

For children with severe mobility impairments, which occur as a result of severe motor impairments (Himmelman, Beckung, Hagberg, & Uvebrant, 2006), learned helplessness is a commonly reported challenge. Learned helplessness occurs when a lack of motor control leads to inconsistent results, which in turn decrease motivation and persistence (Abramson et al., 1978). Besides learned helplessness, children with severe motor impairment also face challenges in accessing opportunities for active involvement. Due to limitations in mobility resulting from their severe motor impairment, they are dependent on others for all physical tasks, including the provision of activities. Children with severe motor impairment are therefore at risk of having limited access to activities as well as being unmotivated when taking part in these activities.

Challenges in access and motivation have an impact on how a child develops, as children need to be actively involved in experiences and interactions for development to occur (Shonkoff & Phillips, 2000). This active involvement has been termed engagement and is described as the involvement in an experience, both for a period of time and at a certain level (R. A. McWilliam & Bailey, 1995).

For typically developing children, engagement increases with age and access to appropriate experiences (McWilliam & Bailey, 1990). In addition, the longer children spend engaged in a task, the more likely they are to succeed, and when success is experienced, their motivation, engagement and persistence on the next task are increased. However, for children with disabilities, engagement has been shown to occur over shorter periods of time and at lower levels than their peers who are typically developing. Children with severe motor impairment, in particular, have been shown to have the lowest levels of engagement (Imms, 2008a).

Due to the challenges that children with severe motor impairment experience with engagement, powered mobility has been suggested to provide them with self-initiated access to mobility and therefore learning opportunities within experiences. Although positive developmental results were identified in this regard (Livingstone & Field, 2014), the specific effect of powered mobility on engagement has as yet not been formally described. Furthermore, since powered mobility is out of reach of the majority of children with disabilities in South Africa due to the cost involved, a non-powered, self-initiated mobility device has been considered for this study as an alternative. Although some research has been conducted in the area of powered mobility, no data is available on the effect of non-powered, self-initiated mobility devices on either engagement or development.

In conclusion, engagement is one of the foundations of development. In the presence of severe motor impairment, engagement tends to decrease due to learned helplessness and the challenges associated with the accessing of experiences. Although a number of studies have been conducted on the introduction of powered mobility for children with severe motor impairment (Livingstone & Field, 2014), the specific effect of powered mobility on engagement in particular

has not yet been described. Because the use of powered mobility is not feasible in South Africa, a cost-effective, non-powered, self-initiated mobility option is needed. This study seeks to determine the effect that introducing non-powered, self-initiated mobility may have on engagement of young children with severe motor impairment.

### 1.3. Terminology

*Engagement:* The time children spend interacting in a developmentally and contextually appropriate manner with the environment both actively and passively (Kishida & Kemp, 2006; R. A. McWilliam & Bailey, 1995). For this study, the developmentally appropriate context for the participants was play. Appropriate interaction was determined to be involvement in play. The manner in which the participants were involved in play was further described as active or passive engagement. *Active engagement:* Engagement where the child actively joins in by interacting appropriately e.g. with the learning environment, manipulating materials or vocalising. *Passive engagement:* Engagement where the child is present and interested in an environment as shown by watching and attending without manipulation or vocalisation (Kishida & Kemp, 2006).

*Learned helplessness:* A cycle in which uncontrollability in motor responses leads to motivational deficits, including decreased voluntary motor responses, passivity, decreased cognitive skills and social impairment (Abramson et al., 1978).

*Mastery motivation:* The motivation of children to master their environment, measured by recording the time that a child spends in goal-directed behaviour in order to complete a task (Redding, Morgan, & Harmon, 1988; White, 1959).

*Non-engagement:* The time children spend interacting in a developmentally and contextually inappropriate manner with the environment either actively or passively e.g. breaking toys or sleeping. During this time no engagement behaviours are present (Kishida & Kemp, 2006; R. A. McWilliam & Bailey, 1995). In terms of the current study, inappropriate interaction was determined to be the presence of behaviours that resulted in the participant being unable to engage in play. The manner in which the participants made use of inappropriate interaction was further described as active or passive non-engagement. *Active non-engagement:* Non-engagement in which the child actively interacts with the environment in an inappropriate manner using manipulation, vocalisation or movement, e.g. shouting, crying or throwing toys. *Passive non-engagement:* Non-engagement in which the child does not interact with the environment, e.g. sleeping (Kishida & Kemp, 2006).

*Non-powered, self-initiated mobility device:* An assistive device that enables a person with a mobility impairment to achieve independent personal mobility (World Health Organization & USAID, 2011). A non-powered or manual device is one that has no motor/electrical system. A self-initiated device is one in which the device is propelled by the user without help from anyone else (Srinivasan & Lloyd, 2011).

*Powered mobility device:* An assistive device that enables a person with mobility impairment to achieve independent personal mobility (World Health Organization & USAID, 2011). A powered mobility device is powered by a motor, and the control interface (e.g. a joystick or switches) is operated by the user (Srinivasan & Lloyd, 2011).

*Severe mobility impairment:* A severe mobility impairment is one in which the person has an inability to perform walking, or climbing stairs or standing, or use of a wheelchair or scooter (Iezzoni, McCarthy, Davis, & Siebens, 2000) Severe mobility impairment usually arises in the presence of severe motor impairment.

*Severe motor impairment:* A severe motor impairment is one in which the motor skills of a person are restricted to such an extent that even antigravity control of the head and trunk is not possible. Self-mobility is extremely limited (Palisano et al., 1997; Rosenbaum et al., 2002) and the person is fully reliant on others for all physical tasks (Ostensjø, Carlberg, & Vøllestad, 2005). In this study, a Gross Motor Function Classification Scale (GMFCS) (Palisano et al., 1997) level V is considered a severe motor impairment.

#### 1.4. Abbreviations

ASBI	Adaptive Social Behavior Inventory (Hogan, Scott, & Bauer, 1992)
BFMF	Bimanual Fine Motor Function (Beckung & Hagberg, 2002)
CP	Cerebral Palsy
ECA	Ecological Congruence Assessment (Wolery, Brashers, & Nietzel, 2002)
ECERS-R	Early Childhood Environmental Rating Scale (Harms, Cryer, & Clifford, 2005)
ECI	Early Childhood Intervention
E-Qual (III)	The engagement quality observational coding system (McWilliam, 1995)
E-Qual ITIE	Engagement quality and incidental teaching for improved education ( McWilliam & Casey, 2004)
ESCAPE	Ecobehavioural System for Complex Assessment of Preschool Environments (Carta, Greenwood, & Atwater, 1986)

GMFCS	Gross motor function classification system (Palisano et al., 1997)
ICER-R	The Individual Child Engagement Record – Revised (Kishida & Kemp, 2009)
ICF-CY	The International Classification of Functioning, disability and health, for Children and Youth (World Health Organization, 2007a).
ITERS	Infant Toddler Environment Rating Scale (Harms et al., 2005)
Life-H	The assessment of life habits for children (Noreau et al., 2007)
PKBS	The preschool and kindergarten behavior scales (Merrell, 1994)
STU	Survey of technology use (Scherer, 1998)

### **1.5. Overview of the chapters**

This study is presented in seven chapters. Chapter 1 presents the problem statement and the context for the study. Frequently used terms are described, abbreviations are explained and an outline of the chapters is provided.

Chapter 2 presents early childhood development as the foundation for future learning. It highlights the role of active involvement in learning and discusses engagement as a measure of active involvement. Engagement in typically developing children is discussed, as well as the challenges in engagement when disabilities are present. In particular, the challenges in engagement for children with severe motor impairment are explored. Based on the challenges identified, current intervention practices are introduced. These focus on the use of powered mobility. This is followed by a discussion on challenges in the implementation of powered mobility in low and middle income countries, which include the cost of powered mobility devices and weaknesses in research supporting their use. The chapter concludes with a discussion on the possibility of using

non-powered, self-initiated mobility in place of powered mobility, but highlights a lack of knowledge of the relationship between mobility and engagement.

The methodology of the study is presented in Chapter 3, together with the aims and design. The research phases are outlined and the objectives and outcomes of the pilot studies are described. The main study is described in terms of the participants (selection, recruitment and descriptions), materials and equipment, procedures (general and data collection), data analysis and procedural and data reliability.

Chapter 4 describes processes from the pre-experimental phase of the study including material development, selection and adaptation. The chapter begins with a description of the theoretical foundation of the non-powered mobility programme. It describes the motor skill teaching procedures to be used, the analysis of the components of movement, the general procedures to be followed and the teaching criteria to be achieved. This is followed by a description of the procedures followed in the selection of the ICER-R (Kishida, Kemp, & Carter, 2008) as the tool to measure engagement in this study. The chapter concludes with the presentation of the procedures used in the translation of materials used in the study.

The results of the study are presented in Chapter 5. The data from the study is presented graphically. This is followed by a description of the data, statistical analysis and comparison of the data across participants for effect. First the effect of the non-powered mobility programme on engagement and non-engagement is described, and this is followed by active and passive engagement as well as active and passive non-engagement.

In Chapter 6 the results of the study are discussed. The discussion follows the structure of the Model of Change in Motor Abilities and Engagement in Self-care and Play of Children with Cerebral Palsy (CP) (Chiarello, Palisano, Bartlett, & McCoy, 2011). Child components (body structures and functioning), associated conditions and adaptive behaviour are discussed in relation to the results of the study.

Chapter 7 provides a short summary of the study. This is followed by an evaluation of the study, a discussion of the clinical implications and recommendations for future research.

## **1.6. Summary**

This chapter presented the problem statement. The role of engagement was highlighted as an element that is affected by learned helplessness and limited access to experiences for children with severe motor impairment. Current intervention strategies that make use of powered mobility were referred to, including the challenges that their implementation poses. The use of non-powered, self-initiated mobility was suggested and identified as the aim of this study. The frequently used terms were defined and abbreviations explained, followed by a brief overview of the chapters in this study.

## CHAPTER 2: LITERATURE REVIEW

### 2.1. Introduction

This chapter begins with a discussion of early childhood development, focusing on the role of active involvement in development. The discussion continues, highlighting the description of active involvement, first in mastery motivation and then in engagement. Measurement of engagement is discussed and the presentation of engagement in typical development is highlighted. This is followed by a discussion on the impact that the presence of any impairment has on engagement for young children, and then specifically, the effect of motor impairment on engagement for young children. The co-occurrence of learned helplessness and a lack of access, and their influence on engagement are explored in children with severe motor impairments. Next, the focus is on intervention strategies, including both powered and non-powered mobility for children with severe motor impairment. The strengths and limitations of these strategies in a South African context are highlighted. Finally, the use of a non-powered, self-initiated mobility device as an intervention strategy for children with severe motor impairment is proposed.

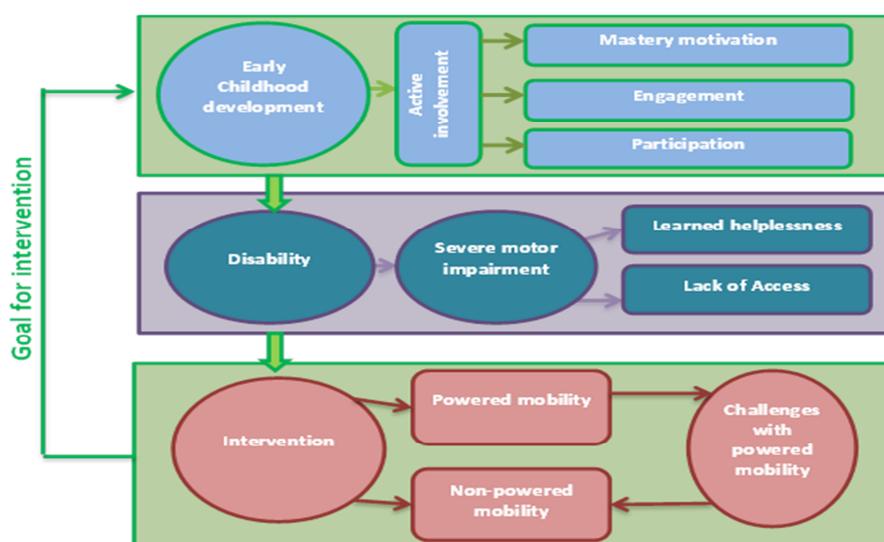


Figure 2.1: Structure of the literature review chapter

## 2.2. Early childhood development

Development, particularly in early childhood, is a foundation for future success and achievement (Shonkoff & Phillips, 2000). As described by early childhood development theorists, this development comes about through experiencing and interacting with the environment. During such experiences children typically assimilate and adapt information that furthers their own development. For young children, experiences arise from daily activities (Dunst, Hamby, Trivette, Raab, & Bruder, 2000), including routines, play and socialisation. Children are not passive passengers within experiences, but have an innate drive to actively master and explore (Shonkoff & Phillips, 2000).

The role of active involvement in development is supported by Piaget (1964), who considered development as being possible only in the presence of active involvement. According to Greenough, Black and Wallace (1987), active involvement is a prerequisite for the production of an active response by the child, which is required for development. Such active involvement of a child in an experience can be enhanced through interactions with both objects and people. Almost a century ago, Vygotsky (1966) created the term scaffolding to describe the role of the partner in guiding the child to achieve more than would have been accomplished independently. Recently, the role of interaction in providing a response from which the child can develop has been elaborated further in the Bioecological Model of Bronfenbrenner and Morris (2006).

The activities in which children are able to experience, interact and develop are the planned and unplanned, structured and unstructured daily activities in which they are able to take part (Dunst et al., 2001). However, as early childhood development theorists studied development further, they encountered a challenge, namely that two children taking part in the same activity –

both classified as ‘actively involved’ – could present with different developmental outcomes (Hauser-Cram, 1996). Other Studies that were conducted to determine the components of active involvement highlighted the individual motivation of the child to be actively involved in the experience as a differentiating factor (McWilliam, Trivette, & Dunst, 1985; Piaget, 1964; Shonkoff & Phillips, 2000; Yarrow et al., 1983).

Initially the motivation to be involved in a task was termed mastery motivation (Redding et al., 1988) and was defined as the motivation of a child to master the environment. It was measured by recording the time that a child spent in goal-directed behaviour to complete a task, and greater time spent on a task was seen to indicate greater motivation (Piaget, 1964; Redding et al., 1988; White, 1959). Mastery motivation was described as the “foundation upon which development occurred” (Hauser-Cram, 1996, p. 236), with development and mastery motivation linked by the assumption that the more time children spent on a task, the more opportunities for problem solving they would encounter, and the greater their development would be. Studies confirmed this hypothesis with results indicating that higher mastery motivation leads to improved cognitive development for both typically developing children and children with cerebral palsy (Jennings, Yarrow, & Martin, 1984; Majnemer, Shevell, Law, Poulin, & Rosenbaum, 2010; Yarrow et al., 1983).

Although mastery motivation provided a measure of active involvement, it was limited to a single task on a single occasion. As such, it was challenged as being too limited to provide sufficient input to relate to global development. This proposition was supported by a longitudinal study with 35 typically developing children whose mastery motivation and cognitive functioning were assessed both at 1 and at 3½ years of age by Jennings and others (1984). Although this study

reported some continuity between mastery motivation and cognitive functioning, a wide range of behaviours needed to be studied to identify it (Jennings et al., 1984). Similarly, as early childhood settings were studied, the need to consider the child's active involvement in more than one task across multiple environments became evident. This was particularly true of preschool environments where development occurs as a result of the involvement in multiple learning opportunities throughout the day (McWilliam et al., 1985). Researchers then proposed that it was not only the time spent on individual tasks that contributed to development, but the overall composition of a child's day (Almqvist, 2006; McCormick, Noonan, & Heck, 1998; McWilliam & Bailey, 1995; Pinto, 2006), expanding the notion of mastery motivation into engagement.

### **2.3. Engagement**

Engagement was operationally defined as “the time children spent interacting with the environment in a developmentally and contextually appropriate manner” (McWilliam & Bailey, 1995, p.123). The concept arose from mastery motivation and similarly proposed that the more time spent in an experience, the more time there would be to practise skills that could lead to development. This was confirmed by de Kruif and McWilliam (1999) in their study on developmental age, global and observed engagement. In this study, 62 preschool children were observed in a classroom setting. Their developmental age and engagement were measured and compared. The comparison revealed a positive relationship between developmental age and engagement, even for children with a range of disabilities (including cerebral palsy, global developmental delay and established syndromes) (de Kruif & McWilliam, 1999). The results of the study by de Kruif and McWilliam were confirmed by Casey, McWilliam and Sims in 2012,

who linked the developmental quotient of both typically developing and disabled (global developmental delay and autism) children to the time children spent in sophisticated engagement.

Engagement is nonetheless not only a measure of time, but also a measure of level of involvement. Level of engagement is measured on a continuum from non-engaged to engaged. Within both engagement and non-engagement, lower levels are described as more passive, for instance watching, while higher levels are described as more active, for instance manipulating objects (Adamson, Bakeman, & Deckner, 2004; de Kruif & McWilliam, 1999; Kishida & Kemp, 2006; McWilliam & Bailey, 1995). It was proposed that the higher the level of engagement, and the more time that a child spent at that level, the higher the possibility of development (McWilliam & Bailey, 1995). The relationship between level of engagement and development was confirmed by Cielinski, Vaughn, Seifer and Contreras (1995) in a study on the relationship between sustained engagement and play for typically developing children and those with Down's syndrome. This study demonstrated that sustained engagement correlated with a higher levels of quality in play for both groups of children, although the Down's syndrome children had lower average scores than their typically developing peers. (Cielinski et al., 1995).

### **2.3.1. Measurement of engagement**

Although described as a continuum, the specific levels of engagement and their definitions vary according to the focus of the study in which engagement is measured. Studies on the engagement of individual children in classrooms have often used the E-Qual (III) system (Engagement Quality through Observational Coding) (McWilliam, 1995), which represents engagement through the levels of *non-engaged*, *attention*, *undifferentiated engagement*, *participation*, *pretend* and *persistence*. Each level within this scale focuses on the manner of the

child's interaction with the environment. In contrast, the State Based Coding System (Adamson et al., 2004) has been used to evaluate the relationship between language and engagement for young children, including those with autism and Down's syndrome. As a result, the 11 levels within this scale focus on the manner in which the child is engaging with the partner. The State-based coding system describes the levels of engagement as *unengaged*; *on-looking*; *person*; *object*; *supporting joint*; *coordinated joint*; *symbol only*; *person-symbol*; *object symbol*; *symbol-infused supported joint* and *symbol-infused coordinated joint*. A final example (but by no means the only other measure of engagement) is that of the Individual Child Engagement Record – Revised, ICER-R (Kishida & Kemp, 2009). This measure is used in classrooms, as is the E-Qual (McWilliam, 1995), but it was developed specifically for use with severely impaired children. It has only two levels, *non-engagement* and *engagement*. However, within each level, the manner of engagement is described as *active* or *passive*. For all measures, the amount of time spent at each level of engagement is recorded.

Based on the need of the particular study, the exact tool used for the measurement of engagement therefore varies. In spite of their differences, the tools share a number of key components. The E-Qual and the ICER-R (Kishida & Kemp, 2009) both focus on classroom settings and engagement in the task at hand, while the State-Based Coding System focuses on the dyad between a young child and its partner. The E-Qual and State-Based Coding System have multiple levels of engagement (9 and 11 respectively), while the ICER-R (Kishida & Kemp, 2009) has four. Each of the tools mentioned identifies changes not only through global increases in engaged time, but also through the changes in the patterns of time spent at each level of engagement. (Section 4.3 contains a list of engagement measures for young children.)

Although engagement has been well used both in individual and in preschool and early intervention settings (McWilliam, Scarborough, & Kim, 2010; Pinto, 2006), it has recently been challenged as having too narrow a focus. With the introduction of the Biopsychosocial Framework of Health by the World Health Organization in 2001, an expansion in the field of Early Childhood Intervention (ECI) was heralded. This proposed that a focus on “involvement in life situations” was required, termed participation (World Health Organization, 2007; p. 9, 248 & 251). Participation is said to extend beyond engagement by including both the child’s interaction partner and the environment in the components for assessment.

The move towards participation nevertheless remains a theoretical move currently, as neither the specific components of participation, nor the mechanisms through which they contribute have been agreed upon or described in a manner that allows for functional measurement (Adolfsson, Malmqvist, Pless, & Granuld, 2011; Chiarello et al., 2012, 2014; Coster et al., 2011; Imms, 2008b; Mcconachie, Colver, Forsyth, Jarvis, & Parkinson, 2006; Palisano et al., 2012). This challenge has affected the development of tools to measure participation, particularly for young children, and those with disabilities, for whom the selection remains limited and incomplete (Adolfsson et al., 2011; Coster & Khetani, 2008; Mcconachie et al., 2006; Phillips, Olds, Boshoff, & Lane, 2013). In a review on instruments available for the assessment of activity and participation of children and adolescents with disabilities in 2013, the authors noted that no single instrument was currently available that measured participation to its full extent (Phillips et al., 2013).

Due to the challenges associated with participation and the focus of this study on young children in a single intervention setting, engagement (which boasts established tools for measurement) remains the focus. However, since mastery motivation, engagement and

participation in active involvement share the same foundation, the three terms have been considered interchangeable with regard to the evidence that each provides in respect of the role of motivation for development in children.

### **2.3.2. Development and engagement**

Both mastery motivation and engagement have been described as a foundation for development, and have been widely studied for the sake of a better understanding (de Kruif & McWilliam, 1999; Jennings et al., 1984; Kishida & Kemp, 2009; Kolehmainen et al., 2011; Majnemer et al., 2010; McWilliam & Bailey, 1995; Rosenshine, 1983). Such studies have indicated that for typically developing children, both age and cognitive development are correlated with higher levels of engagement. McWilliam and Bailey (1990, 1995), de Kruif and McWilliam (1999) and Aguiar and McWilliam (2010) studied the relationship between developmental age and engagement and found that for 32, 32, 49 and 112 typically developing preschool children respectively, a statistically significant correlation was evident between the children's age and level of engagement, with older children showing more sophisticated engagement. In addition, children with high levels of persistence were recorded to have statistically higher levels of engagement than their peers. In the studies, however, non-engagement was more susceptible to environmental factors than to age (Aguiar & McWilliam, 2010; de Kruif & McWilliam, 1999).

In addition to age, the number of available opportunities for learning and the appropriateness of these opportunities are positively linked to engagement for typically developing children. Higher numbers of appropriate activities lead to higher levels of engagement as shown by Doke and Risley (1972) in their study on the organisation of day-care environments, and a lack of sufficient materials for children to use resulted in lower participation for the children in the day-

care. This result was confirmed by Ridley, McWilliam and Oates (2000) who studied the use of engagement as a measure of programme quality in preschools. Their study determined that engagement was indeed an effective measure of programme quality. Higher quality programmes, as measured using the ITERS (Harms, Cryer, & Clifford, 1990) and the ECERS-R (Harms et al., 2005), were seen to elicit higher levels of engagement. The higher quality programmes, in turn, were noted to supply more appropriate opportunities for interaction with materials.

In addition to age, time and available opportunities, Rosenshine (1983) describes the progressive nature of engagement in his review of studies on teaching functions. He notes how time spent in engagement allows for the development of engagement such that future engagement extends for greater periods of time and at higher levels (Rosenshine, 1983). The reasons why engagement tends to develop future engagement have been explained as a consequence of success. Where more time is spent on a task, the task is more likely to succeed. Success, in turn, increases the motivation (engagement) and persistence on the next task (Linnenbrink & Pintrich, 2003; Malone, Michael, & Langone, 1999; Yarrow et al., 1982).

Consequently, for typically developing children, *age, availability of opportunities* and *success* have been reported to combine in engagement to lay the foundation for their development.

### **2.3.3. Impairment and engagement**

For typically developing children there are positive correlations between engagement and age (Aguiar & McWilliam, 2010; de Kruif & McWilliam, 1999; McWilliam & Bailey, 1990, 1995), and between engagement and cognitive development (Rosenshine, 1983). Children with various disabilities however have been reported to have reduced engagement; Down's syndrome

(Cielinski et al., 1995) mild-moderate developmental delay (McWilliam & Bailey, 1995), participation, autonomy; motor impairment (including cerebral palsy), intellectual impairment, ADHD, (Eriksson, Welander, & Granlund, 2007; Fauconnier et al., 2009; Lepage, Noreau, & Bernard, 1998; Voorman et al., 2006) and persistence, motor impairment, developmental delay (Hauser-Cram, 1996; Jennings, Connors, & Stegman, 1988) in comparison with their typically developing peers. Although certain of these studies have focused on children with specific impairments, none provides details on the severity or pattern of impairment for the participants.

Hence, to better understand the relationship between engagement and impairment, a literature search was conducted. As this was a scoping review, mastery motivation, engagement and participation were all included in the search. Seeing that the focus of this study is on young children with severe motor impairment, studies describing the relationship between engagement and motor impairment were of greatest importance. Articles selected for inclusion met the criteria of being applicable to younger children (the studies needed to include children younger than 10 years of age, and be applicable to preschool type activities) with motor impairments (but not to the exclusion of additional impairments) and provide clinical data on the mastery motivation, engagement or participation of these children. The process that was followed is illustrated in Figure 2.2.

The search was conducted using Academic Search Premier, CINAHL, E-Journals, ERIC, Health Source – Nursing/Academic edition, Humanities Source, Masterfile premier, Medline, TOC Premier and all articles in English were considered. The following search terms were used: *Mastery motivation, engagement or participation* (in title). As this study focused on young children, *young child\** was also included. Because the researcher had past experience of finding

only a limited number of studies when physical impairment or motor impairment was specified, a general disability term, *disab\**, was used for this search. Due to the use of *disability* rather than a more specific motor impairment term, exclusions for conditions in which motor impairment is not a primary component were used. These included: *not autism, not ADHD, not dyslexia, not deaf\*, not visually impaired*. Additional terms such as *parent, school* and *social* were excluded to maintain the focus on young children.

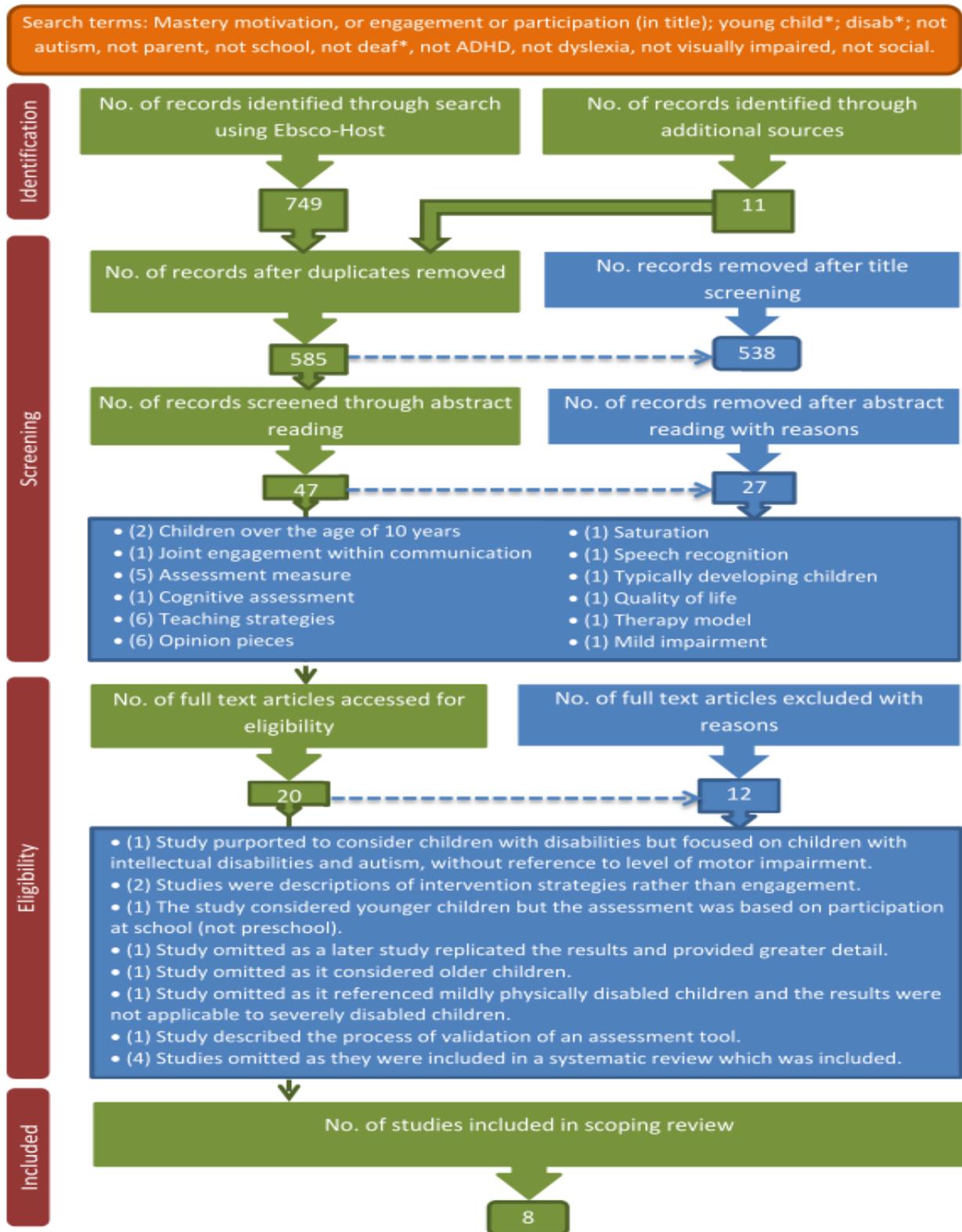


Figure 2.2: Prisma flow diagram of the literature search process (Moher, Liberati, Tetzlaff, & Altman, 2009)

The search identified a total of 749 articles, to which were added 11 articles that had been hand searched. The hand searched articles were referenced in the identified articles, but had not been located by the search engines. Once duplicates had been removed, 585 articles remained. The titles of these articles were read and those not related to the engagement of children with motor impairment were excluded. Due to the wide scope of the search terms, this process resulted in 538 articles being excluded. The abstracts of the 47 remaining articles were read, and again any articles not meeting the inclusion criterion of relating to engagement of young children with motor impairments were removed. This resulted in the exclusion of 27 articles for the following reasons: two articles related to children over 10 years of age, while one article dealt with joint attention which is a specific communication function. Five studies described the process of validating assessment measures for engagement, but did not add to knowledge about the engagement of children with motor impairments. One article related to cognitive assessment, rather than engagement. Seven studies related to specific teaching strategies for engagement, but did not provide data on the engagement of young children with motor impairments, while six articles were opinion pieces and therefore eliminated as they did not include data. One article referred to engagement but measured saturation, and another referred to speech recognition software. One article considered only typically developing children while another referred to mildly impaired children, the results of which were not applicable to children with severe motor impairment. The final article that had to be excluded referred to quality of life rather than engagement.

The remaining 20 articles were read in full, after which 12 were excluded for the following reason: The first was based on a focus on autism and intellectual impairment, and did not refer to motor impairment. Two studies focused on intervention strategies for engagement but did not

provide data on young children with motor impairment and engagement. A further two studies were applicable to older children. One study was excluded, based on the presence of a later larger study that followed the same methodology and produced the same results, but with increased measurement precision (same author). A further study referenced mildly disabled children, and the results were therefore not applicable to severely impaired children, while another described an assessment measure. The final four studies to be excluded were part of a systematic review (which was included).

The remaining eight studies that provided information on the engagement of young children, including those with motor impairments, are presented in Table 2.1 below. Each was analysed for quality of evidence based on the guidelines provided by the American Academy for Cerebral Palsy and Developmental Medicine (AACPDm). The levels for quality of evidence provided by the AACPDm suggest that only studies at levels I and II provide strong evidence of effect, level III moderate and levels IV and V weak evidence. (Darrah, Hickman, O'Donnell, Vogtle, & Wiart, 2008).

*Table 2.1: Studies on the engagement of children with disabilities*

Author (Date)	Aim	Term: Definition	Sample	Design	Methods and measuring instrument	Results	Relevance to current study	Quality of evidence
Jennings et al. (1988)	To determine if the presence of a physical handicap alters the development of mastery motivation in the preschool years.	Mastery motivation: not defined	22 children with motor impairments and 39 typically developing children, assessed at 3½ and 4½ years of age.	Comparative survey group design. A group of physically impaired children was compared to the group of typically developing children in two different contexts.	Three components of mastery motivation were observed and recorded in specific tasks for persistence, curiosity and preference, and three in unstructured play: unfocused, duration, and complexity. The time spent in each type of mastery was recorded. No specific measuring instrument was named.	In structured tasks, typically developing peers persisted longer and enjoyed challenging tasks more than the physically impaired children, although the impaired children had similar levels of curiosity. In unstructured tasks, the typically developing children had less unfocused time, longer duration and more complexity than their physically impaired peers.	Children with physical impairments are at risk for lower mastery motivation than their typically developing peers.	III
McWilliam & Bailey (1990)	To describe the factors affecting engagement in mainstream settings.	Engagement: The time children spend interacting in the environment in a developmentally and contextually appropriate manner.	16 preschool children with disabilities (mild to moderate developmental delay including motor impairment). 32 preschool children without	Comparative survey group design. Groups with mixed ages were compared to groups with children of the same age.	Engagement was measured using the Engagement Check (R. McWilliam & Bailey, 1990) and the results correlated with activity type and age grouping, age and handicapping condition .	Age was associated with engagement. Engagement with materials was associated with age grouping. Children with disabilities spent more time observing than playing in comparison to their peers.	Children with disabilities showed less active engagement in both structured and unstructured activities.	III

Author (Date)	Aim	Term: Definition	Sample	Design	Methods and measuring instrument	Results	Relevance to current study	Quality of evidence
McWilliam & Bailey (1995)	To examine the effects of disability, age and adult involvement on engagement.	Engagement: The time children spend interacting in the environment in a developmentally and contextually appropriate manner.	disabilities in an inclusive setting. 16 preschool children with disabilities (mild to moderate developmental delay including motor impairment). 32 preschool children without disabilities in an inclusive setting.	Comparative survey group design. Groups with mixed ages were compared to groups with children of the same age.	Observation of the engagement of participants in free-play and adult-involved sessions using the Engagement Check (R. A. McWilliam & Bailey, 1995).	Children with disabilities spent significantly less time interactively engaged with adults, attentively engaged with peers and in mastery engagement with materials. They spent significantly more time passively non-engaged than their typically developing peers.	Children with disabilities have decreased engagement, even when developmental age is controlled for.	III
Hauser-Cram (1996)	To determine the mastery motivation of toddlers with motor impairments, developmental delay and typical development.	Mastery motivation: Independent and persistent task-directed behaviour in problem-posing situations that are moderately challenging.	25 children with motor impairments, 25 children with developmental delay and 25 typically developing children. 1-2 years old.	Comparative survey triplet design. Children were matched into triplets of one child each with motor impairment, with developmental delay and with typical development.	The children were observed in problem-solving behaviour on two tasks, based on the procedures of Morgan, Busch-Rossnagel, Maslin-Cole, & Harmon (1991).	No significant difference was measured for the three groups on mastery motivation. Seizure disorders, prematurity, cognitive impairment and maternal input showed the strongest effects on mastery motivation.	In the sensorimotor stage of development, mastery motivation for children with impairments is the same as that of their typically developing peers.	III
Law et al.	To determine	Participation:	427 children	Quantitative	The children were	When adjusted for	Although	N/A

Author (Date)	Aim	Term: Definition	Sample	Design	Methods and measuring instrument	Results	Relevance to current study	Quality of evidence
(2004)	the relationship between diagnosis, function and participation for children with physical disabilities.	involvement in life situations.	with motor impairments aged 6 to 12 years old.	survey.	allocated to a group based on diagnosis. Participation was measured using the children's assessment of participation and enjoyment (King et al., 2005)	age and sex, diagnostic category did not significantly affect participation.	physical impairments result in decreased participation, diagnoses do not provide a mechanism to describe the effect of the impairment on participation.	
Voorman et al. (2006)	To describe the activities and participation of children with cerebral palsy and to examine the relationship with personal factors and disease characteristics.	Participation was not defined.	110 children with CP and a mean age of 11 years 3 months.	Quantitative survey	Results of the PEDI, Vineland Adaptive Behaviour scales, and GMFCS were compared using multiple linear regression models.	GMFCS score was significantly associated with mobility, self-care and domestic life. Cognitive impairment was also significantly associated with self-care and domestic life but to a lesser degree. Cognitive impairment and epilepsy were the most significant factors associated with social life.	Activities and participation can to a large extent be explained by only a few factors, the strongest being gross motor functioning.	N/A
Imms (2008a)	To review research on children with cerebral palsy to determine	Participation: the active taking part in or sharing in something with	A systematic review of 40 studies on personal, environmental	Systematic review.	Design, participant, outcome selection and analytical procedures were	Children with disabilities had reduced participation compared to their peers, and children	Children with disabilities have decreased participation	II

Author (Date)	Aim	Term: Definition	Sample	Design	Methods and measuring instrument	Results	Relevance to current study	Quality of evidence
	the extent of their participation and the factors that influence it.	a clear understanding of the sense of community in the partnership. Also: involvement in life situations.	and occupational factors relating to participation of children with CP (6 met the criteria for this review).		critiqued for methodological quality using the MacMaster Guidelines. Key areas of the studies were synthesised using narrative.	with neurological impairments had the poorest outcomes among disability types. Factors reported as having an impact on participation were primarily child focused. The level of functioning and severity of impairment was found to have an impact on participation to a greater extent than diagnosis. Environmental factors identified included the location of children, social support and physical accessibility – all of which had an effect on participation.	in comparison to their peers. Children with neurological (including motor) impairments have the most severe participation restrictions. The severity of impairment is related to participation. Environmental factors also have an impact on participation.	
Casey, McWilliam, & Sims (2012)	To determine to what extent child and classroom characteristics affect the engagement displayed by	Engagement: The amount of time children spend interacting with the environment (adults, peers materials) in a	61 pre-schoolers with disabilities in early childhood classrooms, including developmental	Observational study group design.	Incidental teaching, the children's developmental quotient, the quality of peer interactions and engagement in	Developmental quotient and the quality of peer interactions accounted for much of the variance in engagement categories. Incidental	Development is linked to engagement as shown by the developmental quotient. The use of	V

Author (Date)	Aim	Term: Definition	Sample	Design	Methods and measuring instrument	Results	Relevance to current study	Quality of evidence
	children with disabilities.	developmentally and contextually appropriate manner	delay (with motor impairment) and autism, aged 10 to 65 months.		five categories were measured for the participants. The results were then correlated. The E-Qual ITIE (R. A. McWilliam & Casey, 2004) was used.	teaching was a significant predictor of sophisticated engagement.	incidental teaching can positively influence the level of engagement.	

The studies identified in the search, presented in Table 2.1, provided evidence that for children with disabilities (including but not limited to motor impairment), engagement (including participation and mastery motivation) was different from and reduced in comparison to their peers. The results obtained by McWilliam and Bailey (1990), who considered the engagement of developmentally delayed pre-schoolers in an inclusive setting, indicated that for the children with delays, less active engagement was evident, and they spent up to three times longer observing than their peers did. The same authors reported similar results in 1995. In the later results (in spite of corrections being applied for developmental age) the children with delays were noted to show significantly lower engagement than their peers, both in general engagement and engagement with materials (McWilliam & Bailey, 1995). Although McWilliam and Bailey (1990, 1995) reported differences in engagement for pre-schooler with impairments, a study on the mastery motivation of 1- and 2-year-olds conducted by Hauser-Cram (1996) showed no difference in the mastery motivation of the children while still in the sensorimotor phase. In this study Hauser-Cram considered the mastery motivation over two problem-solving tasks for children with physical impairments, developmental delays and typical development. No difference between the mastery motivation of the children was noted, with variability in results related to factors such as seizure disorders, prematurity, cognitive impairment and maternal input. Following the presentation of these results, Hauser-Cram proposed that the deterioration in mastery motivation observed with children with motor impairment occurred after the sensorimotor phase of development (1996). The assertion that a deterioration in mastery motivation only occurs after the sensorimotor phase of development explains why other studies on disability and engagement of slightly older children showed a relationship between engagement and disability, when Hauser-Cram (1996) did not. Although the results presented by these studies provide some evidence of the impact of

impairments on engagement for young children, conclusions need to be drawn with care, as the level of evidence presented in the studies by McWilliam and Bailey (1990; 1995) and Hauser-Cram (1996) fall at a level III for scientific rigor for studies with group designs (moderate strength) (Darrah et al., 2008). Hence further confirmation is required by additional studies.

For McWilliam and Bailey (1990; 1995), their results are supported by Casey, McWilliam and Simms (2012) in a study on the effect of classroom characteristics on engagement. This study provided evidence that developmental age, when measured using the developmental quotient, correlated with engagement. This study however similarly falls within a level V for the strength of the evidence it produces (Darrah et al., 2008). Hence, although there is limited strength in the studies identified, the presence of a number of corroborating results is suggestive of decreased engagement in activities for children with various impairments compared to their peers.

#### **2.3.4. Motor impairment and engagement**

The information from Table 2.1 presented thus far focused on the impact of impairments (including, but not limited to motor impairment) on engagement (including mastery motivation and participation). This study however focuses on children with severe motor impairment in particular. Hence the remainder of the studies, which focus on motor impairment will be presented here. Although this information is presented as relating to participation, the links between participation and engagement lead to its being considered applicable to engagement too.

To begin with, the review identified containing the strongest scientific evidence (level II) (Darrah et al., 2008), is that on studies on the participation of children with CP (Imms, 2008a). This review provided results for children with CP which correspond to those of the children with

other disabilities presented previously. These results indicated lower participation for children with CP than for their peers, across the 40 studies reviewed. In addition Imms (2008a) reported evidence that the severity of the impairment also impacted participation, with children with more severe impairments having lower levels of participation. These conclusions echoed those of Voorman et al., (2006) who surveyed 110 young children with CP, and concluded that the levels of motor functioning strongly predicted participation levels.

In apparent contrast to the systematic review, Law et al. (2004), surveyed the diagnostic categories of children with physical impairments and correlated those with participation. Their results did not indicate a significant relationship between diagnosis and participation (engagement). However, the authors did assert that a move beyond diagnosis into functioning was required if the full extent of participation was to be measured. This assertion supports the studies which correlated the severity of impairment with level of participation (engagement). Since children with greater levels of impairment also have greater functional limitations (Arthur-Kelly, Bochner, Center, & Mok, 2007).

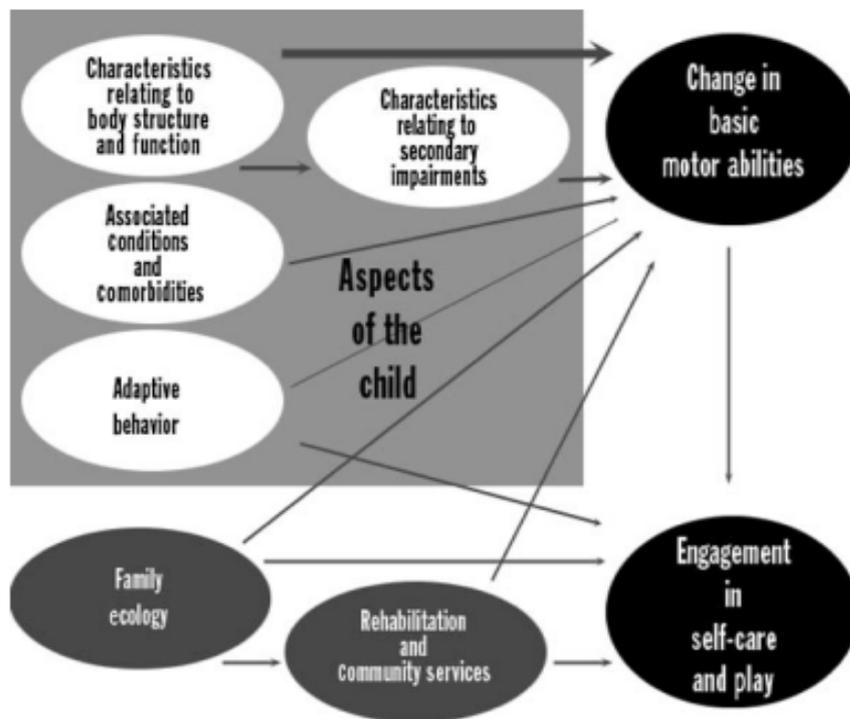
Hence, as with disabilities, evidence on the relationship between motor impairments and participation or engagement is limited. However, the results of both the systematic review and survey studies suggest that the engagement of children with motor impairments is lower than that of their typically developing peers, with children with severe motor impairment being at the greatest risk based on their level of motor impairment and the functional limitations associated with this.

#### **2.4. Engagement and intervention**

Due to the increased risk of reduced engagement faced by children with severe motor impairments (Chiarello et al., 2011), intervention is recommended for these children from an early age. Intervention has been described as having participation as the main focus (Sakzewski, Boyd, & Ziviani, 2007) as it is through increased participation that engagement is possible and success can be achieved. According to Kolehmainen et al. (2011) and Perenboom and Chorus (2003), a positive cycle of engagement and success can reduce the effect of an impairment.

In an attempt to assist interventionists to facilitate increases in engagement during intervention for children with motor impairments, Chiarello et al. (2011) produced the Model of Change in Motor Abilities and Engagement in Self-care and Play of Children with CP. This model highlights the relationship between change in motor abilities and engagement, and supports the literature that provides evidence of motor impairment being a significant factor in engagement for children (Imms, 2008a; Voorman et al., 2006). The model is depicted in Figure 2.3 below.

In the model below, proposed by Chiarello et al. (2011), the engagement of young children in self-care and play can be seen to be directly related to basic motor abilities. Basic motor abilities and engagement are, however, also related to child and environmental factors, both directly and indirectly. The ‘child’ factors include characteristics of body structure and function, as well as secondary impairments, associated conditions and adaptive behaviour, while ‘environmental’ factors include family ecology, and rehabilitation and community services.



**Figure 2.3: Model of Change in Motor Abilities and Engagement in Self-care and Play of Young Children with CP** (Chiarello et al., 2011, p.152)

In line with the model presented by Chiarello et al. (2011), interventionists have focused on both child and environmental factors as goals when working with children with severe motor impairment. Two of these factors reported in the literature on intervention are discussed further. The first factor involves learned helplessness (child factor) and the second the assumption that children with motor impairment have reduced access to activities (child and environmental factor).

The hypothesis of learned helplessness proposes that for children with motor impairment, decreases in motivation are said to arise from the “effects of experience with uncontrollability” (Abramson et al., 1978, p. 50). This hypothesis states that where outcomes are uncontrollable, motivation, cognition and emotion are all affected (Abramson et al., 1978). Studies on learned helplessness have provided supporting evidence for the presence of deficits in children with motor

impairment, with results indicating that they have lower scores on persistence in motor and cognitive tasks (Majnemer et al., 2010). They are also less active in their pursuit of play, more dependent on others to initiate this (Kraat, 1985), less active in conversation with many non-responses, less inclined to initiate turn taking and more inclined to limit their responses to direct answers (Basil, 1992; Clarke & Kirton, 2003; Light, Collier, & Parnes, 1985). These results confirm the relationship suggested between success, engagement and persistence (see Section 2.3.2). As in the presence of learned helplessness, decreased success in a task leads to decreased motivation and decreased persistence (Linnenbrink & Pintrich, 2003; Malone, Michael, & Langone, 1999; Yarrow et al., 1982), while decreased motivation in turn results in decreased engagement time and level.

Regarding the relationship between access and experience, Eriksson et al. (2007) argue that children with motor impairment have fewer opportunities for experience. Their argument was in line with that of Ostensjø, Carlberg and Vøllestad (2005), who correlated limitations in functioning and an increasing need for assistance with an increasing GMFCS level for young children (Palisano et al., 1997), and that of Arthur-Kelly, Bochner, Center and Mok (2007) who described children with severe motor impairment as reliant on support for all physical tasks. A limitation in access to experience results in limitations to the amount of time during which engagement is possible, and has an impact on the overall level of engagement that can be reached (de Kruif & McWilliam, 1999).

Following the identification of the factors of learned helplessness and lack of access to experiences as goals for intervention, a mechanism was proposed for addressing these areas, namely the provision of alternative mobility (Butler, 1986; Forsyth & Jarvis, 2002). In this regard,

independent mobility was highlighted as having a stronger impact on children's development than has mobility not controlled by the child (Anderson et al., 2001; Thelen, 2000b). The requirement for self-initiation of mobility relates back to the innate need of a child to independently explore and master tasks in the environment (Hauser-Cram, 1996; Redding et al., 1988; Shonkoff & Phillips, 2000; Thelen, 2000a). Furthermore, various studies propose that if self-initiated mobility was implemented as early as possible, the consequences of failure and the development of learned helplessness may be arrested (Bushnell & Boudreau, 1993; Butler, 1986; Palmer et al., 2012; Shonkoff & Phillips, 2000; Thelen, 2000a).

#### **2.4.1. Intervention using alternative mobility**

Self-initiated mobility for children with severe motor impairment as proposed by Butler (1986) involved the use of powered mobility devices. Other researchers pursued this trend and conducted numerous studies on powered mobility. A systematic review followed on powered mobility outcomes for infants, young children and adolescents (Livingstone & Field, 2014). The review was conducted using both digital and hand searches of the literature. From these searches, 296 articles were identified and screened before 96 were identified for abstract review. The abstract review revealed 29 articles that were included in the systematic review. Each article was analysed for level of evidence, components of the ICF-CY (World Health Organization, 2007a) and common results. The results of the review were then put to an expert panel consisting of authors who had published research on powered mobility (Livingstone & Paleg, 2013). All authors who had published literature on powered mobility were invited to participate, with a total of 16 consenting. The expert review identified a number of key elements within the reviews. The first of these is that positive impacts on overall development using powered mobility were evident, even

for very young children and those who were severely disabled. The second is that the results of the studies supported the hypothesis that mobility plays a key role in development. A third finding was that powered mobility plays a key role in the development of functional independence and self-initiated mobility, although it was noted that this does not necessarily coincide with increased interaction with objects (Livingstone & Field, 2014).

In spite of supportive results from most studies on powered mobility, one study stands out as having contradictory results. Since it was the only study to directly mention engagement, it requires specific discussion, even though it only provided evidence at a level IV in terms of scientific rigor (Darrah et al., 2008). This study considered the positive effects of the early introduction of powered mobility on children's psychosocial and play skills (Guerette, Furumasu, & Tefft, 2013) and reported that, following the introduction of powered mobility, significant increases in parental perceptions of social skills, the number of mobility activities during indoor play and improvements in the qualitative level of outdoor play were reported. No change in verbal interactions was noted, but a significant decline in the child's ability to remain engaged in a task was recorded. Although a decline in engagement as measured in this study is concerning, the manner in which the results were obtained requires evaluation.

The measure of engagement used in the study by Guerette, Furumasu and Tefft (2013) was the Survey of Technology Use (STU) (Scherer, 1998). This is a parent report survey with the aim of determining if the assistive technology provided to their child is a good fit (Lenker & Paquet, 2003; Scherer, 1998). It is not a specific measure of engagement, nor is it referenced in the literature on engagement. The measure is a parental report rather than a direct measure of child

engagement and for this reason further investigation – including the direct measurement of engagement – is required to confirm the results obtained by Guerette et al. (2013).

In spite of the remaining studies supporting the use of powered mobility as an intervention tool, challenges are still evident. As identified by Livingstone and Field (2014) in their systematic review, only two of the 29 articles had strong evidence ratings based on experimental designs and quantitative data, with the remainder reliant on descriptive data. As a result, in spite of the purportedly positive outcomes, the methodological challenges within these studies have impeded the use of powered mobility in intervention regimes (Henderson, Skelton, & Rosenbaum, 2008).

A further challenge for the implementation of powered mobility with young children is that the introduction of a mobility device does not in itself increase a child's mobility or exploration. In order for a mobility device to be functionally used, a training programme is required (Butler, 1986). According to Ostensjø et al. (2005), who reviewed studies on the use of assistive technology for young children with CP, there is evidence of a lack of mobility training on the introduction of powered mobility devices and they specifically noted an absence of direct training for both the children using powered mobility devices and their parents. Without a training programme in place, negative perceptions on the value of powered mobility can develop due to the device not being used by the child.

In spite of the challenges with the research on powered mobility, experts in the field concur that the use of powered mobility for children who are not independently mobile, enhances independence and overall development. They specifically note that for children without a means of mobility, the risk of developing learned helplessness is increased and their development is at risk.

Based on this finding, Livingstone and Paleg (2013, p. 220) propose that “all children who lack efficient mobility should be considered for powered mobility”, including those for whom mobility may be a temporary need.

For children in low and medium income countries, however, the introduction of powered mobility devices is further complicated by economic, accessibility and governmental issues. Currently it is reported that approximately 1% of the population of low and middle income countries require wheelchairs (powered and non-powered), while current supply rates meet only 14-37% of the demand (Borg, Lindström, & Larsson, 2011; Pearlman, Cooper, Zipfel, Cooper, & McCartney, 2006; World Health Organization & USAID, 2011). In South Africa specifically, where both manual and power wheelchairs should be available through the government health system (free of charge or subsidised according to the family’s resources), actual supply is limited by budgets in individual centres and often focused on persons who have a good prognosis for independent mobility, while other users have to purchase their own wheelchairs privately (Visagie, Scheffler, & Schneider, 2013). With powered wheelchairs on average costing more than the entire annual income of the average worker (Statistics South Africa, 2012), high unemployment (Taborda, 2013) and workers who support multiple family members make it nearly impossible for families to save for such a costly device. Hence the use of powered mobility remains out of reach of many families.

#### **2.4.2. Non-powered mobility devices**

With powered mobility excluded as a viable option in South Africa, alternative mobility options were considered. Specifically for this study, a non-powered device was sought by the researcher that could provide young children with severe motor impairment with an affordable

mechanism for self-initiated mobility, even if a different device was envisaged for the long run. The use of a temporary device for initial mobility rather than waiting for a permanent device was supported by the expert panel in the review conducted by Livingstone and Field (2014) and Livingstone and Paleg (2013). This would prevent learned helplessness and promote development even if a child would later become independently mobile or require a different type of device. The implementation of mobility as early as possible to prevent the development of learned helplessness is also supported by Butler (1986) and Jones, Mcewen and Hansen (2003).

A systematic review conducted in 2011 (Borg et al., 2011) to summarise the knowledge on assistive technology for low and lower-middle income countries from 1995 to 2011 was referred to for identifying available non-powered mobility devices. The review was conducted using both electronic and complementary searches, and identified 52 articles for inclusion. Articles were categorised into type of technology and the results were summarised. Although articles on wheeled mobility devices focused on non-powered wheelchairs, no information relating specifically to children was available (Borg et al., 2011).

Since limited information on the devices in use by children in developing countries was evident, alternative research on non-powered mobility devices for young children with physical impairments had to be considered. This revealed a focus on the use of non-powered devices such as wheelchairs, which were used as positioning devices rather than mobility devices, for children with severe motor impairments (Kim & Mulholland, 1999). Studies using the non-powered devices for positioning proposed that optimal positioning increased the child's ability to participate in daily life activities (Ostensjø et al., 2005; Palisano et al., 2003). Contrary to this assumption, multiple systematic reviews of these studies found limited evidence to support the hypothesis that

improved positioning leads to improved participation (Chung et al., 2008; Farley et al., 2003; Harris & Roxborough, 2005; Mcnamara & Casey, 2007; Ryan, 2009; Stavness, 2006).

Further to a lack of improved participation, evidence has suggested that devices used for positioning, do not commonly provide for independent mobility for children with CP (Ryan, 2009). For children with severe motor impairment, wheelchairs typically focus on providing strong trunk and hip support in order to allow for improved limb functioning (Ryan, 2009). However such positioning can result in difficult producing the movements required for mobility, such as pushing the wheels of a wheelchair, or pushing off the floor with feet to move a wheelchair. For children with severe motor impairments, the challenge of mobility in a non-powered wheelchair is exacerbated by the need to perform complex movements in order to get the wheelchair moving (pushing a wheel round uses shoulder, arm and hand control). Hence even when positioning is good, the children remain reliant on others to bring experiences to them, and neither learned helplessness nor lack of access is addressed.

However, one therapy device that was identified as a possible option was the scooter board—a rectangular board with four wheels, covered with a soft layer – that occupational therapists use in sensory integration therapy (Davidson & Williams, 2000). Although the aims of sensory integration therapy do not include the development of mobility for motor-impaired children, letting a young child lie on a scooter board in prone position provides for its making use of either or both arms and legs for self-initiated mobility. In addition the arm and leg movements for mobility on a scooterboard can be gross extension and flexion patterns or more refined movements. For children with motor impairments, such a non-powered mobility device could provide opportunities for

independent movement and exploration. In addition, a scooter board can be made without specialised manufacturing equipment at a low cost (less than R300/ \$30).

For young children, positioning in prone is considered appropriate as this allows for access to items and playmates at floor level, as is the norm in this age group. The scooter board would indeed be a transient mobility option only and not one for permanent use, as positioning in upright is a preferred and more appropriate position for children as soon as schooling begins (McKeever, Rossen, Scott, Robinson-Vincent, & Wright, 2013). Such a device could be used to provide opportunities for mobility experience and interaction on the floor for a young child, but would need to be supported by other devices for social and ADL requirements (Kim & Mulholland, 1999).

The scooter board could therefore provide a cost-effective option for introducing non-powered, self-initiated mobility for young children preventing the onset of learned helplessness, while providing opportunities for experience and development until a more permanent mobility device is identified. However, the introduction of any mobility device must be accompanied by a training programme if it is to be successful (Butler, 1986; Ostensjø et al., 2005). The efficacy of the device also needs to be determined. This study proposes that the foundation for all development, namely engagement, be measured.

## **2.5. Conclusion**

Engagement is the mediator within an experience that allows for development. For children with severe motor impairments in particular, engagement is at risk due to the difficulties they experience in their motor control, which lead to a lack of access and learned helplessness.

Although research on intervention has provided positive indications of improved development for children with severe motor impairments, using powered mobility. This is not a feasible solution in low and middle income countries, hence a non-powered, self-initiated mobility device is being considered. This study seeks to determine if the use of such a device can in fact improve the engagement of young children with severe motor impairment.

## **CHAPTER 3: METHODOLOGY**

### **3.1. Introduction**

This chapter describes the research methodology used in this study. The aims of the study are discussed, followed by a description of the design and its application to this study. The study phases are depicted next, followed by the pilot study objectives, procedures and recommendations. The material and equipment used in the study are outlined, and the sampling procedures and selection criteria for participants described. The participants in this study are then portrayed, followed by a description of the general and data collection procedures. Finally, the data analysis procedures and reliability of data are discussed.

### **3.2. Research question**

What is the effect of non-powered, self-initiated mobility on the engagement of young children with severe motor impairment in play activities?

### **3.3. Main aim**

The main aim of the study was to determine the effect of non-powered, self-initiated mobility on the engagement of young children with severe motor impairment.

In order to address this, the following sub-aims were delineated:

#### **3.3.1. Sub-aims**

- i. To develop a non-powered mobility programme for young children with severe motor impairment. A description of the theoretical orientation and development of the non-powered, self-initiated programme appears in Section 4.2.

- ii. To describe the process of the selection of the measure of engagement used in this study, namely the Individual Child Engagement Record – Revised (ICER-R) (Kishida & Kemp, 2009) (see Section 4.3).
- iii. To implement the non-powered mobility programme with four participants with severe motor impairment.
- iv. To determine the effect of the non-powered, self-initiated mobility on the engagement of young children with severe motor impairment using the ICER-R (Kishida & Kemp, 2009).
- v. To describe the effect of the non-powered, self-initiated mobility on engagement, using graphically represented data and statistical analysis.

### **3.4. Research design**

A multiple probe design across participants was used for this study (Gast & Ledford, 2010). In such a design, the independent variable is applied to multiple participants in a sequential manner. In single-subject experimental designs such as the multiple probe design across participants, each participant serves as its own control. This is achieved through establishing a baseline prior to the implementation of intervention. Results obtained during and following intervention are compared to the baseline of each participant, rather than to a separate control group (Gast & Ledford, 2010). The effectiveness of the independent variable is evaluated based on changes in the dependent variable across multiple participants (Baer, Wolf, & Risley, 1968; Gast & Ledford, 2010; Horner & Baer, 1978).

The multiple probe design across participants is of use when true experimental studies are not possible due to a lack of homogeneity in participants (Hawkins et al., 2007; Higginbotham & Bedrosian, 1995; Zhan & Ottenbacher, 2001), and where the reversal of behaviour following

intervention is not required. The latter is particularly relevant where developmental skills that cannot be reversed, are learnt (Gast & Ledford, 2010; Horner & Baer, 1978). However, limitations in the multiple probe design across participants include the lack of information obtained through such a design on intra-subject replication, as the independent variable is introduced to the participants only once (Gast & Ledford, 2010). The generalisation of results is also limited by the small number of participants in the study (Gast & Ledford, 2010). Furthermore, challenges arise when the introduction of the independent variable results in a global increase in functioning – not only in the desired area. In situations such as this, it is difficult to separate the independent variable from extraneous variables (Horner & Baer, 1978).

This multiple probe design across participants as used in the current study comprised a baseline, an intervention and a post-intervention phase. Probes were conducted in all three phases. The independent variable was referred to as the non-powered mobility programme developed for this study (see Section 4.2). The non-powered mobility programme comprised two motor skill components, namely initiation of movement and continuation of movement. Each of these motor skill components required four sessions to achieve the teaching criterion, hence the programme involved eight sessions. The dependent variable, engagement, was probed using the Individual Child Engagement Record – Revised (ICER-R) (Kishida & Kemp, 2009), which is a standardised, commercially available measurement tool.

The study commenced with a baseline phase where engagement, using the ICER-R (Kishida & Kemp, 2009), was probed for at least three consecutive sessions. The non-powered mobility programme was then implemented with the first participant. The remaining participants remained in baseline phase and were probed weekly. When Participant 1 achieved the teaching criterion for

the first motor skill component (four sessions), the non-powered mobility programme was implemented with the next participant. During implementation of the programme the participants were probed daily. This same process was repeated for the remaining participants.

### 3.5. Research phases

The study comprised two phases, namely the pre-experimental phase and the experimental phase, as illustrated in Figure 3.1.

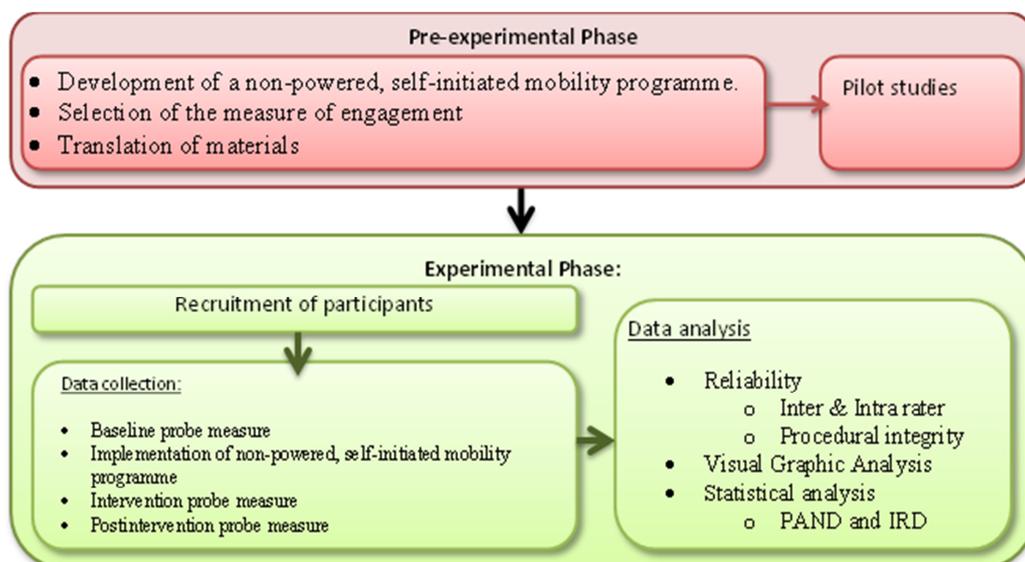


Figure 3.1: Overview of the phases of the study

Figure 3.1 provides a brief overview of the phases of the research study. The processes followed in the pre-experimental phase are all described in Chapter 4 since they involved material development. The development of the non-powered mobility programme is outlined in Section 4.2, the selection of the engagement measure follows in Section 4.3, and the process of material translation is explained in Section 4.4. The pilot studies, which are presented in the current chapter (Section 3.6), were followed by an experimental phase and began with participant selection, recruitment and pre-assessment (Section 3.7). This was followed by the implementation of the

general procedures (Section 3.9), which included general and data collection procedures, data analysis (Section 3.10) and data reliability (Section 3.11)

### **3.6. Pilot studies**

Following the development of the non-powered mobility programme, two pilot studies were conducted as part of the pre-experimental phase. The aim was to assess the appropriateness of the selection criteria; the materials for participant selection; general procedures; the data collection itself, and data analysis procedures planned for the study. The recruitment of participants for the pilot study was conducted through contact with private therapists in the Ethekweni meto area. Selection of participants and procedures used in the pilot study resembled those outlined for the main study.

#### **3.6.1. Pilot study**

The objectives of pilot study 1, which involved one participant, are outlined in Table 3.1.

##### **3.6.1.1. Participant**

The participant was a boy aged 3 years and 9 months. He was diagnosed with quadriplegia with fluctuating muscle tone. He lived in an urban setting with both his parents, in a house made of bricks, and his home language was English. The participant's father worked full time and his mother part time. His mother was the primary caregiver and was assisted by a facilitator. The participant presented with more severely involved upper than lower limbs. He had significantly increased muscle tone in his arms and hence limited use of these. He had fluctuating muscle tone in his trunk and increased muscle tone in his legs with effort. All unsupported movement resulted in a gross extension pattern. Whereas he was unable to roll, sit, crawl or walk independently, he

managed to hold his head up in upright and prone positions. The participant apparently enjoyed musical toys and watching television, and was able to produce a single word, “car”. To communicate negative feelings such as discomfort and pain, he would use crying, and for positive feelings such as enjoyment he would use laughter. When bored, he was reported to sleep. The participant did not attend school. He received physiotherapy and speech therapy weekly, and occupational therapy one week every month. He was carried in the home and in the community.

***3.6.1.2. Pilot study 1: Objectives, materials, procedures, results and recommendations***

Table 3.1: Pilot Study 1 – Objectives, materials, procedures, results and recommendations

Objective	Materials/ Measure	Procedures	Results	Recommendations
1. To evaluate the appropriateness of selection criteria for participants.	Selection criteria (Appendix E)	The six potential participants were screened for inclusion in the study.	Five of the children referred had a GMFCS level IV classification and were found to be mobile. Only one was not yet mobile, He had a GMFCS level V classification (Palisano et al., 1997).	The GMFCS (R J Palisano et al., 1997) criteria should be changed to level V only.
2. To evaluate the appropriateness of the GMFCS family report questionnaire (Dietrich, Abercrombie, Fanning, & Bartlett, 2007).	The GMFCS Family Report Questionnaire (Dietrich et al., 2007) (Appendix A)	The GMFCS Family Report Questionnaire (Dietrich et al., 2007) was provided to the mothers to complete.	The GMFCS Family Report Questionnaire (Dietrich et al., 2007) was successfully completed by the caregiver.	No changes recommended.
3. To determine the appropriateness of the video camera placement for scoring of the ICER-R (Kishida & Kemp, 2009).	Video cameras and tripods. Video recordings of sessions	The video cameras were set up to record the whole intervention area. The cameras used to record each session. The assessment measures were scored using the video captured.	The video placement provided a recording from which the ICER-R (Kishida & Kemp, 2009) could be scored.	No changes recommended
4. To determine the adequacy of the video recordings for data analysis in terms of sound and visual quality for the scoring of the ICER-R (Kishida & Kemp, 2009).	Video recordings of sessions The ICER-R (Kishida & Kemp, 2009)	The video recordings were watched and the ICER-R (Kishida & Kemp, 2009) scored.	The sound and visual quality of the video recordings was adequate for data scoring.  Scoring of the ICER-R (Kishida & Kemp, 2009) using a separate device to produce the audio tone/ beep (as suggested by the manual) is challenging, as it is not possible to pause the video and keep the tones synchronised (Appendix B).	No changes recommended.  The video data should be digitally edited to include the tones (beeps) for scoring.
5. To determine the adequacy of the procedural scripts for	General procedure scripts and checklist a) Welcome	The video was watched and the checklist completed.	General procedures were implemented. a) Procedures ran as anticipated.	a) No changes recommended

Objective	Materials/ Measure	Procedures	Results	Recommendations
implementing the non-powered mobility programme in terms of the general procedures.	b) Toy selection c) Play processes		b) Procedures ran as anticipated. c) During the intervention phase the participant took a long time to reach the toy at the bottom of the ramp, which was demotivating for him. <ul style="list-style-type: none"> <li>- Verbal input for play procedures was not consistent.</li> <li>- During the post-intervention phase, the participant initiated movement that was not successful. No specifications were provided to deal with this.</li> </ul>	b) No changes recommended c) For the first criterion of the intervention phase, toys will be placed on the ramp as well as at the bottom of the ramp. <ul style="list-style-type: none"> <li>- A verbal script for play procedures is required.</li> <li>- The post-intervention phase script needs specifications for facilitation of movement.               <ul style="list-style-type: none"> <li>i.) Movements should not be prompted.</li> <li>ii.) Movement initiated by the participant but not successfully completed, can be facilitated.</li> <li>iii.) Facilitation to be provided through the use of a forward chaining approach.</li> </ul> </li> </ul>
	d) Play conclusion e) Session conclusion		d) Procedures ran as anticipated. e) Procedures ran as anticipated.	d) No changes recommended. e) No changes recommended.
	Appendix C Prompting hierarchy scripts Appendix D	The prompt hierarchy was implemented and videoed. The sessions were watched and evaluated using the checklist.	The participant initially made use of extension of his legs to initiate movement. With the prompting hierarchy, this progressed to include reciprocal movements and later arm movements as well.	No changes recommended.
6. To evaluate the duration in which the learning criterion was attained in order to set teaching criterion.	Two mobility skill programme components	The intervention was implemented and videoed. The response of the participant to input across each teaching criterion was studied.	Attaining the teaching criterion took too long. The participant began to move to the next learning criterion in Session 4. He showed particular fatigue on days 5 and 10 of intervention.	The teaching criterion should be reduced to four ½-hour sessions per teaching component (total 8 sessions).
7. To evaluate the design of the scooter board.	Scooter board (Section <b>Error!</b> <b>Reference source not found.</b> )	The comfort of the participant in using the scooter board was observed.	Although the participant was comfortable on the scooter board, drooling was problematic. A small towel needed to be placed under his	A waterproof covering is recommended for the scooter board.

Objective	Materials/ Measure	Procedures	Results	Recommendations
			chin to prevent the foam on the scooter board from becoming wet. No safety concerns were recorded.	No changes recommended.
8. To evaluate the procedures for the administration of the probe.	Probe materials as specified for this study: - ICER-R (Kishida & Kemp, 2009) (Section 4.2) Appendix B)	The safety of the participant was observed. The adjustments required to keep the participant in position were observed. Probe sessions were conducted according to the specified guidelines (Appendix B). The videos were watched and the ICER-R (Kishida & Kemp, 2009) completed. The results were evaluated.	In spite of the hip strap, the participant slipped backwards off the board. Since the participant had poor motor organisation skills, he took time to get involved in play during a session. Recording his engagement as soon as the session begins does not provide a true reflection of his engagement and skills.	The addition of an additional strap between the legs up to the hip strap is recommended to prevent backward sliding off the board. A set time, repeatable across participants, needs to be determined at which point the probe test will be begun. It is recommended that this be five minutes after the start of the session. The start of the session is defined as the time when the participant is offered a choice for the first time.
9. To determine the appropriateness of data analysis and presentation.	Scores from probes on the ICER-R (Kishida & Kemp, 2009)	The data was presented graphically.	The data was presented visually. Engagement and non-engagement graphs are direct opposites of each other.	Data needs to be presented in a format in which all types of engagement are clearly presented. Multiple graphs are needed.
10. To evaluate the independent raters in the scoring of the ICER-R (Kishida & Kemp, 2009).	ICER-R Manual (Kishida & Kemp, 2009) Video footage of sessions from pilot study 1.	The independent raters were introduced to the ICER-R (Kishida & Kemp, 2009). Five-minute clips from the pilot study were scored independently and the results then discussed in a group. This was repeated until the raters achieved more than 80% agreement for three sessions.	Nine sessions were watched until agreement at the required level was reached.	No changes recommended.
11. To evaluate the data collection reliability.	Intra-rater data on the ICER-R (Kishida & Kemp, 2009) from 33% of the sessions conducted.	The researcher randomly selected and re-scored 33% of the data one month after the initial pilot study. The results were statistically compared to the results of the	P-values of 0.395 were obtained for engagement and 0.453 for non-engagement. With significance measured at 5%, no significant difference was evident in the ICER-R	No changes recommended.

Objective	Materials/ Measure	Procedures	Results	Recommendations
12. To determine the reliability of the Procedural Integrity Checklist.	<p>Video footage of baseline, intervention and post-intervention sessions.</p> <p>Procedural Integrity Checklist for general procedures and the prompt hierarchy checklist (Appendix C, Appendix D)</p>	<p>initial scoring by means of the Wilcoxon One-sample Test to compare the means.</p> <p>Two independent raters randomly selected and rated 33% of the data, using the procedural integrity checklists. For each session the 15-minute portion during which probes were conducted was rated for procedural integrity.</p>	<p>(Kishida &amp; Kemp, 2009).</p> <p>a)General procedures: Concern was raised regarding a lack of detail and specificity for general play procedures and the absence of a verbal script for procedures.</p> <p>b)Prompt hierarchy: Concern was raised regarding difficulty in scoring the mobility intervention. It was not possible to record the use of multiple prompts for one movement, and it was difficult to determine the difference between a tactile prompt and facilitation.</p> <p>The scores from the raters and the researcher varied greatly.</p>	<p>a)The general procedures checklist requires revision with detailed descriptions of each play process included. At each stage of the session, an option for completed correctly and completed incorrectly is required. The specific verbal input to be used at each step of the study was added.</p> <p>b) The arrangement of the scoring of prompt hierarchy needs adaptation. Placement in table format where each goal is scored on a new row allows for multiple prompts for each goal to be scored.</p> <p>The sections for tactile prompting and facilitation were combined.</p> <p>Reliability was not determined statistically due to the challenges with the checklist. The above recommendations need to be implemented in the next pilot study.</p>

It is evident from Table 3.1 that the first pilot study resulted in changes to the selection criteria of participants. Changes involved the general procedures script relating to play with toys, the introduction of the verbal script for play and changes to the post-intervention script relating to movement facilitation. The teaching criteria was reduced to four sessions, and changes to the scooter board were recommended. Changes were made to the time at which the probe test was begun, as well as to the format of the prompt hierarchy script, and inter-rater reliability was not measured due to the changes required. The changes in the general procedures, prompting hierarchy and verbal input and reliability indicated the need for a second pilot study.

### **3.6.2. Pilot study 2**

The second pilot study was conducted primarily to determine if the changes made to the general procedures, prompt hierarchy and verbal input were adequate. It was also conducted on a single participant.

#### **3.6.2.1. Participant**

The participant was a boy aged 4 years and 5 months, diagnosed with severe athetoid cerebral palsy. He had lived in an urban setting, in a care home for profoundly impaired children, since 18 months of age, and had contact with his family only during holidays. The language used in the home was English and the participant had been in the English environment for 35 months, although his home language was isiZulu. He presented with more severely involved upper than lower limbs. He was able to make large uncoordinated movements with his arms and legs. Voluntary movements of the participant were impacted by athetoid patterns. When moved without full support, a gross extension pattern resulted. The participant was unable to maintain any antigravity position without full support. He was reported to enjoy musical toys and computer-based activities. To communicate negative

feelings such as discomfort and anger, he would use crying and throw temper tantrums. For positive feelings such as enjoyment he would use laughter. The participant attended a centre for children with disabilities in the mornings and an aftercare for typically developing children in the afternoons (both English medium). He received occupational therapy weekly. He was carried at home and pushed in a full support buggy when moving around in the community.

### ***3.6.2.2. Pilot study 2: Objectives, materials, procedures, results and recommendations***

As can next be derived from Table 3.2, the second pilot study found that the changes in terms of the following were adequate: selection criteria; general procedures relating to play; a verbal script and the post-intervention script for movement facilitation; teaching criteria; the scooter board; the time at which the probe was started; the prompt hierarchy script. The final recommendation that emerged from the second pilot study was to separate – for ease of reference – the Procedural Integrity Checklist into separate lists for general procedures and the prompt hierarchy. This was done prior to the start of the main study.

Table 3.2: Pilot Study 2 – Objectives, materials, procedures, results and recommendations

Objective	Materials	Procedures	Results	Recommendations
1. To determine the adequacy of the digitally added audio tone to enhance the scoring of the ICER-R (Kishida & Kemp, 2009).	Video recordings of sessions.	The video recordings were edited as recommended in pilot study 1 and watched again. The ICER-R (Kishida & Kemp, 2009) was completed.	Scoring of the ICER-R (Kishida & Kemp, 2009) was assisted by the editing of the video to include the auditory tones. The video could be stopped and re-played as required and different raters would hear the tone at exactly the same time.	No changes recommended.
2. To determine the adequacy of the procedural scripts for play procedures, including the verbal script for play.	General procedures, scripts and checklist. Play process (Appendix C)	The video was watched and the checklist completed.	General procedures were implemented. Procedures ran as anticipated.	No changes recommended.
3. To evaluate the duration in which the learning criterion was attained in order to set teaching criterion.	Two mobility skill programme components.	The intervention was implemented and videoed. The response of the participant to each mobility skill component was studied.	The participant completed the learning criteria for skill 1 during the 4th session. The participant reached the learning criterion for skill 2 during the 4 <sup>th</sup> session of teaching .	4 sessions are sufficient for a participant to meet the learning criterion of each mobility skill component..
4. To evaluate the use of waterproof material and additional straps on the scooter board.	Scooter board Section 3.8.2.1	The comfort of the participant on the scooter board was observed.	The participant was comfortable on his scooter board, and a vinyl covering prevented the foam from getting wet from saliva.	No changes recommended.
		The adjustments required to keep the participant in position were observed.	The additional straps on the scooter board resulted in the participant requiring minimal adjustments of his position.	No changes recommended.
5. To evaluate the procedures for the starting of the probe five minutes into the intervention session.	Probe materials as specified for this study: - ICER-R (Kishida & Kemp, 2009) (Section 4.2; Appendix B)	Probe sessions were conducted according to the specified guidelines. The videos were watched and the ICER-R (Kishida & Kemp, 2009) was completed. The results were evaluated.	The start time five minutes after the start of the session resulted in the participant being involved in play when the scoring of the measures began.	No changes recommended.

6. To determine the appropriateness of data analysis and presentation.	- Scores from probes on the ICER-R (Kishida & Kemp, 2009).	Data was presented graphically.	The data was presented visually. All the components of engagement were clearly presented.	No changes recommended.
7. To evaluate the data collection reliability.	- Inter-rater data on the ICER-R (Kishida & Kemp, 2009), from 33% of sessions conducted.	The independent raters randomly selected and scored 33% of the data. The results were compared to the data obtained by the researcher using the Kruskal Wallis test for difference.	P-values of 0.1094 for engagement and 0.4641 for non-engagement were obtained. With significance measured at 5%, it was evident that no significant difference was noted in data for the ICER-R (Kishida & Kemp, 2009) between raters.	No changes recommended.
	- Intra-rater data on the ICER-R (Kishida & Kemp, 2009) from 33% of sessions conducted.	The researcher randomly selected and re-scored 33% of the data two weeks after the initial scoring. Reliability was conducted using the Wilcoxon One-sample Test to compare the means.	P-values of 0.257 for engagement and 0.414 for non-engagement were obtained. With significance measured at 5%, it was evident that no significant difference was noted in data for the ICER-R (Kishida & Kemp, 2009) between scorings.	No changes recommended.
8. To determine the ease of scoring of the Procedural Integrity Checklist, including the verbal script and the prompt hierarchy procedures.	Video footage of baseline, intervention and post-intervention sessions.  Procedural Integrity Checklist for general procedures and the prompt hierarchy. (Appendix C) (Appendix D)	The independent raters randomly selected and rated 33% of the data, using the Procedural Integrity Checklist. For each session, the 15-minute portion of the session during which probes were conducted was rated. Scores were then compared statistically using the Wilcoxon Two-sample Test.	Procedural integrity scores of between 94% and 96% were obtained for the general procedures and the prompt hierarchy.  No significant difference between the scores was evident.	The Procedural Integrity Checklists for general procedures and the prompt hierarchy should be split into two separate checklists for separate scoring.

### 3.7. Participants

Participants were selected by means of non-probability purposive sampling. For single-subject research designs such as the multiple probe design across participants, homogenous participants are preferred to ensure that the results obtained are reliable (Wolery & Lane, 2010). However, due to the heterogeneity of participants with severe impairments, participants were selected based on specific features that were applicable to the research question (Higginbotham & Bedrosian, 1995). Due to the low incidence of severe motor impairment within any population (0.4% as measured in a rural South African Community) (Kromberg et al., 1997), the number of children who were candidates for this study was low. In addition, although English is the second most spoken home language in KwaZulu-Natal (13%), this is greatly exceeded by isiZulu (77%) (Statistics South Africa, 2012). During the identification of participants for the pilot phase of the study it became evident that it would not be possible to find sufficient English speaking participants to perform a multiple probe design across participants (minimum 4) (Ferron et al., 2011). Due to this it was decided to use isiZulu speaking participants for the main study.

### 3.7.1. Selection criteria.

After the pilot study, adjustments were made to selection criteria (Appendix E) and the final selection criteria are set out in Table 3.3 below.

*Table 3.3: Selection criteria*

<b>Criteria</b>	<b>Motivation</b>	<b>Method for Measurement</b>
Aged 2 years 0 months to 6 years 11 months	The minimum age was determined by the minimum age for classification on the GMFCS (Palisano et al., 1997). The maximum age was stipulated as the age when upright mobility becomes a requirement for school (McEwen, 1992).	Biographical questionnaire Section 3.8.1.1.1 Appendix F
Severe motor impairment	Severe motor impairment is an impairment where the participant lacks independence in all motor functions, even antigravity positions. Independent mobility is not possible and assistance is required for all activities of daily living (Nakken & Vlaskamp, 2007; Palisano et al., 1997; Roberts, Arthur-Kelly, Foreman, & Pascoe, 2005).	GMFCS family report questionnaire (Dietrich et al., 2007) and confirmed by the child's physiotherapist Section 3.8.1.1.2; Appendix A
isiZulu as home language	As the study was conducted in isiZulu, participants were required to have isiZulu as their home language so that language compatibility would not affect the effectiveness of intervention.	Biographical questionnaire Section 3.8.1.1.1 Appendix F
No peripheral sensory impairment	Participants with diagnosed peripheral sensory impairment were excluded from the study. Sensory impairment can result in additional developmental challenges due to the manner in which a child's ability to perceive the world is affected (e.g. blindness: a child will not automatically seek out a toy at a distance) (Cass, Sonksen, & McConachie, 1994).	Biographical questionnaire Section 3.8.1.1.1 Appendix F
No previous mobility device used	Participants who had previously used a mobility device were excluded from the study in order to mitigate for the possible effects of this.	Biographical questionnaire Section 3.8.1.1.1 Appendix F

### 3.7.2. Recruitment of participants

Telephonic contact was made with non-governmental organisations in the Durban area who work with children with severe disabilities. The area was selected due to its physical accessibility for the researcher (convenience purposive sampling). Additional referrals made by each of the organisations were also followed up. A total of eight organisations were contacted. Five of them expressed interest in the study and were provided with information on the requirements for possible participants, but did not have children who met the participant

criteria. Two organisations indicated that they did not want to participate in the study and one organisation was both interested in the study and had children who met the participant requirements. A meeting was arranged and the organisation was provided with detailed information on the study (Appendix G). The board of the organisation then gave approval for the study (Appendix H).

The centre who gave approval served children with motor impairments. The clients of the centre received intervention on a monthly basis which included group physiotherapy, fine motor, communication and cognitive tasks – completed in play and with singing and music. Intervention at the centre took place in a three-hour session during which caregivers facilitated their own children overseen by the physiotherapist.

The director of the centre provided a list of nine possible participants for the study, and an information morning was organised for the caregivers of those participants. Among the contact details provided, one caregiver did not have a telephone number, and two did not answer their telephones. One caregiver was unable to attend the information session, and five indicated that they would attend.

The information morning with the caregivers took place on the premises of the centre. Although the researcher was competent in isiZulu, a translator was used to ensure that the participants were able to ask any questions that they might have (see Section 4.4 for details on the translation of materials and the preparation of the translator for the information morning). After the presentation, the caregivers were encouraged to ask questions. Of the five caregivers who attended the information morning, one was immediately excluded from the study as the child concerned was mobile. The researcher (and the translator) explained to the caregiver the reasons for her child not being a candidate, and she agreed that it was not a suitable study for

her. The remaining four caregivers had the consent forms read to them in isiZulu and were given the opportunity to consent for their children to participate in the study (Appendix I). Since all four provided written consent for their children to participate in the study, a total of four participants were included in this study. This is the minimum number required for a multiple probe design across participants (Ferron et al., 2011; Murphy & Bryan, 1980).

### **3.7.3. Pre-assessment of participants**

The pre-assessment procedures began immediately once the consent from the caregivers had been obtained. This was done to confirm that the participants indeed met the selection criteria for the study. The procedures were followed in the prescribed order. The pre-assessment procedures included an interview involving the researcher, the translator and the caregiver of the participant. During this interview, the biographical questionnaire (Appendix F) and GFMCS family report questionnaire (Dietrich et al., 2007)(Appendix A) were completed. For each item, the question was asked in English and translated by the researcher. Each participant then spent 15 minutes in a free play session with the researcher so as to establish rapport. During play, the researcher confirmed the physical presentation of the participant through handling, positioning and movement. Table 3.4 provides a detailed description of the four participants (P1, P2, P3 and P4).

Table 3.4: Description of participants

Participant No.	P1	P2	P3	P4
Age at baseline	3 years 1 month	2 years 10 months	5 years 4 months	6 years 9 months
Gender	Male	Male	Female	Male
Home language	isiZulu	isiZulu	isiZulu	isiZulu
Diagnosis	Cerebral palsy, spastic quadriplegia	Cerebral palsy: spastic quadriplegia and Laryngomalacia (resolved)	Spastic quadriplegia and epilepsy resulting from TB meningitis (acquired at age 4 years 1 month)	Cerebral palsy, spastic quadriplegia
Current medical intervention	None	None	Currently on anti-epileptics daily	None
GMFCS level (Palisano et al., 1997):	V	V	V	V
Sensory impairment	None reported	None reported	None reported. P3 presents with a squint, but as reported by her caregiver and supported by her physiotherapist, this does not affect her vision.	None reported
Age at referral to the rehabilitation centre	1 year	Birth	Age 4 – on discharge from hospital following the acquisition of her impairment.	3 years – attended regularly for one year only
Additional therapy	None	None	Physiotherapy and occupational therapy every 8 weeks at a government hospital, focused on the maintenance of range of movement in her joints.	None
Previous mobility device use	None, carried by caregiver	None, carried by caregiver	None, carried by caregiver	None, carried by caregiver
Primary caregiver	Mother	Mother	Mother	Grandmother
Physical abilities	Able to maintain head up when in upright and prone position. Actively moves limbs but generally makes use of a gross extension pattern.	Able to maintain head up when in upright and prone position. Actively moves limbs, but movements are gross and unrefined.	Able to maintain head up when upright. Lifts head momentarily when in prone position. Generally passive with limited initiation of limb movement.	Able to maintain head up when upright. Lifts head momentarily when in prone position. Generally passive with limited limb movement.
Description of play	Enjoys looking at and touching toys.	Loves cars and kicking balls.	Enjoys spending time with people and watching TV.	Looks at toys with which he would like to play. Enjoys social interaction.

### ***3.7.3.1. Participant 1***

Participant 1 was a boy, aged 3 years and 1 month, diagnosed with spastic cerebral palsy. He lived with both his parents in a semi-rural setting, in a house made of bricks. At the time of the study, his father worked and his mother was the primary caregiver. Participant 1 was referred to the rehabilitation centre at 1 year of age because he was developing slowly. He presented with globally increased muscle tone, with upper and lower limbs affected equally. Participant 1 was unable to roll, sit independently, crawl or walk. He was able to hold his head up both in upright and prone positions, but when initiating movement, made use of gross extension patterns. Participant 1 reportedly enjoyed looking at toys and playing with them by touching, although he was not able to pick them up. According to his caregiver, he produced only one word, “nene” – for cup. To communicate negative feelings such as discomfort and pain, Participant 1 would use crying, and he would also cry to gain attention when bored. For positive feelings such as enjoyment he used laughter. Participant 1 did not attend school and stayed at home with his caregiver daily. She transported him on her back, both at home and in the community.

### ***3.7.3.2. Participant 2***

Participant 2 was a boy aged 2 years 10 months, diagnosed with severe athetoid cerebral palsy and laryngomalacia (resolved) at birth. He lived in an urban area in a house made of bricks, and at the time of the study, his father worked full time and his mother, his primary caregiver, attended university part time. She was assisted by family members when she had to attend classes. Participant 2 was referred to the rehabilitation centre on discharge from the hospital at birth. His upper limbs were more severely affected than his lower limbs and he presented with significantly increased muscle tone. He had limited use of his upper limbs and was able to lift his arms in full extension only. His hands were most often fisted. Participant 2

had greater use of his lower limbs. He was able to initiate both extension and flexion with ease, although movements were gross and unrefined. Participant 2 had fluctuating muscle tone in his trunk and therefore required full support of his trunk to be able to move his upper and lower limbs. He was able to roll when lying down but was unable to sit, stand, crawl or walk. Participant 2 made active use of his limbs in all positions. He was reported to enjoy playing with cars and with balls, which he kicked when supported by his caregiver. Participant 2 was able to produce five words: “ma” – mother; “bo” – ball; “moto” – car; “phuz” – drink; “dla” – eat. He reportedly made use of crying to indicate discomfort and pain, as well as hunger and thirst at times. When expressing enjoyment he would laugh, and to express interest, he would point at the item he likes, usually with his lower limbs. When bored, Participant 2 was reported to fall asleep. He did not attend school, and remained at home with his mother each day. He was carried by his primary and other caregivers when out in the community.

### ***3.7.3.3. Participant 3***

Participant 3 was a girl aged 5 years 4 months, diagnosed with profound motor and cognitive impairment and epilepsy. She lived in an urban setting with her mother, grandfather and aunt in a house built of bricks. Her mother was her primary caregiver. Participant 3 became disabled at age 4, when she contracted Tuberculosis Meningitis. On discharge from the hospital, she was referred to the rehabilitation centre. She presented with extremely high global muscle tone. Both upper and lower limbs were maintained in extension, while her hands were fistled and her feet turned inwards. Participant 3 had extremely limited movement and tended to remain passive in the position in which she had been placed. She was able to lift her head for short periods of time when upright and in prone position. She was reported to enjoy spending time with people and watching TV, and reportedly laughed to indicate enjoyment and excitement. She would cry to indicate her needs, as well as any pain, discomfort and anger, and

would sleep when bored. Participant 3 did not attend school and spent each day at home with her caregiver. She did however receive additional physiotherapy and occupational therapy every 8 weeks (1 session of each) at a local hospital (but not during the implementation of the study). She was carried around the house and in the community on her caregiver's back.

#### **3.7.3.4. Participant 4**

Participant 4 was a boy aged 6 years 9 months, diagnosed with spastic quadriplegia at 3 years of age. He lived in a brick house in a rural setting with his extended family (mother, grandparents, other grandchildren, aunts and uncles) and his primary caregiver was his grandmother. Participant 4 was referred to the rehabilitation centre on diagnosis at age 3, but had only been going there regularly for one year prior to the study being conducted. He presented with high muscle tone in all limbs and a limited range of movement in his hips, knees, ankles, elbows and wrists. He also presented with kyphosis and scoliosis of his spine and a windswept posture. Participant 4 had extremely limited movement and tended to remain passive in the position in which he had been placed. He was unable to roll, sit, stand or walk, but was able to lift his head when upright and for short periods of time when in prone position. He was reported to enjoy social interaction greatly. He would look at items that he wanted to play with, but was unable to play with them. Participant 4 was reported to be unable to indicate his need for food or drink, but he would cry to indicate pain or discomfort, and would smile and laugh to indicate enjoyment or excitement. When bored, he would fall asleep. Participant 4 did not attend school, and stayed with his caregiver at home on a daily basis. He was transported on his caregiver's back, both at home and in the community.

### **3.8. Materials and equipment**

#### **3.8.1. Materials**

The materials used as part of the study included standardised tests as well as materials developed and compiled specifically for the study. The process of material development, including the translation of materials will be described in detail in Chapter 4.

##### ***3.8.1.1. Pre-assessment material***

###### **3.8.1.1.1. The biographical questionnaire (Appendix F)**

A biographical questionnaire was developed to obtain biographical information about the child and the parents of the participants. Additional questions relating to the abilities of the participants were also included.

###### **3.8.1.1.2. The Gross Motor Function Classification System family report questionnaire (Dietrich et al., 2007) (Appendix A)**

The family report questionnaire is a brief questionnaire, to be completed by parents, which provides a classification of the gross motor functioning of a child with cerebral palsy. It was developed based on the Gross Motor Function Classification System (GMFCS) (Palisano, Rosenbaum, Walter, Russell, Wood, & Galuppi, 1997) that is widely used by therapists in the field in order for families to be able to provide information on their child. The family report questionnaire has been confirmed as correlating with the actual Gross Motor Function Classification System (Jewell, Stokes, & Bartlett, 2011).

##### ***3.8.1.2. Probe material***

###### **3.8.1.2.1. The Individual Child Engagement Record – Revised (ICER-R) (Kishida & Kemp, 2009) (Appendix B)**

The ICER-R is a measure of child engagement developed by Kishida and Kemp (2009). It is a practical tool for use by practitioners in the field and was developed specifically for application with children with impairments, including severe intellectual and motor impairments (Kishida & Kemp, 2006). The ICER-R (Kishida & Kemp, 2009) has been correlated with other engagement measures such as the E-Qual III (Kishida, Kemp, & Carter, 2008). It was used during probe tests as a measure of the participant's engagement in this study. The selection of this engagement measure is explained in Section 44.3.

The ICER-R was scored as described in the manual (Kishida & Kemp, 2009). A fifteen minute video recording of the session was edited to include auditory tones every fifteen seconds. The video was watched and every time a tone was heard the scorer made a decision regarding the engagement/ non-engagement of the participant based on the play at that time. Secondly a determination of active or passive engagement/ non-engagement was made. Both engagement/ non-engagement and activity/ passivity were determined based on the examples provided in the ICER-R manual (Appendix B). The type of engagement was then recorded on a score sheet. Once each tone had been scored (60 scores), the frequency of occurrence of each type of engagement, active engagement, passive engagement, active non-engagement, passive non-engagement, was calculated after the completion of the scoring.

### ***3.8.1.3. Intervention materials***

#### **3.8.1.3.1. The non-powered mobility programme**

The non-powered mobility programme was developed as a sub-aim of this study. The purpose of this programme was to teach a severely motor-impaired child to make use of a non-powered mobility device. The programme was conducted using motor skill training. The development of the programme is outlined Section 44.2. The intervention is described in Section 3.9.6.

#### ***3.8.1.4. Procedural integrity***

Two checklists were developed to measure procedural integrity.

##### **3.8.1.4.1. General procedures checklist (Appendix C)**

A checklist was developed to rate the procedural integrity of the general procedures applied to each session. The score sheets allowed for each element of each procedure to be scored and sequenced, as recommended by Gast (2010) (Section 44.2).

##### **3.8.1.4.2. Prompting hierarchy checklist (Appendix D)**

A checklist was developed to rate the application of the prompting hierarchy from the non-powered mobility programme. The score sheet allowed for the application of each level of the hierarchy to be scored and sequenced (Section 4.2).

#### ***3.8.1.5. Equipment***

##### **3.8.1.5.1. Non-powered, self-initiated mobility device**

The device selected as the non-powered, self-initiated mobility device for use in this study was a scooter board. This is a rectangular wooden board with wheels on each corner. The boards used in the study were covered with a thin layer of high-density foam and vinyl, and each was made to the size specifications of the participant who would be using it. The board was measured to extend from the shoulder to 20cm above the knee of the participant. The width of the board was equivalent to the width of the participant's torso. A high-density foam wedge was placed from the participant's waist to under the armpits. Webbing safety straps were placed around the torso and hips. Additional webbing straps between the participant's legs ensured that it would not be possible to slide backwards off the scooter board. Participants were positioned in prone on the device, unless they were unable to tolerate this position in

which case side-lying was used. In side-lying, the chest and hip straps were fastened but not the strap between the legs.



Figure 3.2: Photograph of the scooter board used in this study

#### 3.8.1.5.2. Ramp

A wooden ramp 3m in length with a 12° incline was used for developing motor skills in component 1 of the non-powered mobility programme. The ramp was lined with vinyl and had a flat landing at the top with sufficient space on which to turn the scooter board around. It had 10cm-high guides on the sides to prevent a participant from rolling off.



Figure 3.3: Photograph of the ramp used in this study

#### 3.8.1.5.3. Toys

Toys for the study, as specified in the non-powered mobility programme, were specifically chosen for their high reward for mobility and low cognitive load (see Section 4.2). The toys were presented in clear plastic containers and placed in front of the participants so that they could see them. Both the toys and how they were played with are described in Section 4.2. The toys included skittles, trains and cars, balls, etc.



Figure 3.4: Images of the play equipment used in this study

#### 3.8.1.5.4. Recording equipment

A Sony handycam digital video recorder, Sony Ericsson cell phone camera and Canon digital recorder were used to make the video recording. Each was placed on a firm base and the data was stored on memory cards appropriate to the camera.

### 3.9. Procedures

#### 3.9.1. Ethical procedures

Ethical approval in respect of this study was applied for and obtained from the Ethical Committee of the University of Pretoria (Appendix J). Studies involving human participants must ensure that appropriate consideration is given to the principles of autonomy, beneficence, non-maleficence and justice (Gillon, 1994; Reitemeier et al., 2010).

*Autonomy* provides for the independence of the participants to choose to participate in a study. This choice requires information to be provided on all aspects of the study, positive and negative (Gillon, 1994). The information on the current study was provided to the caregivers verbally in isiZulu and in written format (both English and isiZulu) (Appendix G). The caregivers provided informed consent for their children to participate. As the participants of this study were young children with significant motor impairments, it was likely that they had not yet developed the ability to assent (Broome, Kodish, Geller, & Siminoff, 2003; Ondrusek et al., 1998; Reitemeier et al., 2010) and therefore a “non-compliance” clause was used in place of assent. When a participant became upset, the caregiver was given the opportunity to calm

the child and then choose if they wanted the session to continue or not. Caregivers were able to stop the intervention at any time.

*Beneficence* refers to doing good, and participation in a research study should provide benefits for the participants (Gillon, 1994). The benefits in this research study entailed not only a minimum of 15 sessions of play for each participant, but also the fact that the participant was provided with a scooter board and training in its use. For these participants, the development of their independent mobility provided access to new experiential opportunities. At the end of the study, the participants also kept their scooter boards.

*Non-maleficence* refers to doing no harm (Gillon, 1994), and therefore this study considered non-maleficence for both caregivers and participants. The researcher sought to accommodate family routines through flexibility in the scheduling of intervention sessions and funding for transport to and from the research setting. The design of the mobility device and non-powered mobility programme was conducted with safety as first priority at all times.

*Justice* pertains to fairness of the application of the intervention, fairness in the distribution of resources and respect for people's rights (Gillon, 1994). This study sought to determine if non-powered mobility would benefit young children who had no mobility. Strict selection criteria were applied to recruit only participants who were likely to benefit from the intervention.

In order to ensure that the principles of autonomy, beneficence, non-maleficence and justice were met, the language based materials for the study, including those for informed consent and the application of procedures, were translated into isiZulu as this is the predominant language spoken in KwaZulu-Natal (Statistics South Africa, 2012). The process followed in the translation of materials is outlined in Section 4.4.

### 3.9.2. Setting

The study was conducted in a centre for children with disabilities based in a semi-rural area on the edge of the Ethekwini municipality of KwaZulu-Natal. The municipality is the third largest in the country, but it also has the third highest unemployment rate (30%) and the highest number of people per household (4). In the most recent census (2011), 17,1% of the population were recorded as having no income. The majority of the population (62%) spoke isiZulu as home language, followed by English. KwaZulu-Natal has a high rate of illiteracy and 42,6% of its population have completed at most a primary school education (Statistics South Africa, 2012).

The rehabilitation centre comprises a three-room building with a covered front veranda. Due to renovations that took place at the time of the study and the general running of the centre, intervention was conducted both inside and outside on the front veranda. The intervention areas had flat smooth floors. The ramp was placed on the right side of the intervention space. Toys to be played with were stored in boxes against the left wall. A chair was placed on the far side where the caregiver could sit and observe.



Figure 3.5: Photographs of the rehabilitation centre and intervention environment

### **3.9.3. Personnel**

All baseline, intervention and post-intervention procedures were implemented by the researcher. A Speech Language Pathologist registered with the Health Professionals Council of South Africa, who had 15 years experience working in the field, 10 of which were specifically with children with severe disabilities and in under-resourced communities in South Africa. The researcher holds a Masters degree in Early Childhood Intervention with additional certification in Neurodevelopmental Therapy for infants and young children from the South African Neurodevelopmental Therapists Association.

The researcher had previous professional contact with the director of the centre in which the study was conducted, but had never worked in the centre or with any of the participants previously.

### **3.9.4. General procedures**

Following the pre-assessment of the participants, the baseline, intervention and post-intervention phases of the study were implemented using child-led play procedures. Each of these procedures was structured to provide consistent input, both physically and verbally. Four procedural phases were identified: toy selection, beginning of play, continuation of play, and conclusion of play. Within each phase, the input was strictly graded from least to most with specific verbal and physical input defined. Each participant was seen individually at a set time. On arrival they were welcomed to the intervention setting and placed in a prone or side-lying position on their scooter board. The participant was offered a choice of toys to play with. Throughout the study the same toys were available for play. These were selected during the development of the intervention programme (Section 44.2). The researcher then followed the participant in play for up to 10 minutes per toy. After 10 minutes (or sooner if indicated by the participant), the researcher asked if the child would like to continue or would like a new toy. If

the first option was elected, play was continued. If the child preferred to have a new toy, the current toy was packed away and a new selection provided. At the end of the session the participant was thanked for the time and offered a sticker as reward. Each session lasted 30 minutes (Appendix C).

### **3.9.5. Probe tests**

Probe tests were conducted for 15 minutes as part of all sessions. The probe test comprised the ICER-R (Kishida & Kemp, 2009) (Section 4.3) and was scored afterwards, while watching a video recording of the session. The probe test was completed on the same day as each session and adhered to the guidelines in the manual. The test was conducted in the same manner across all phases of the study. Each probe test video began five minutes after the start of the session, which was determined as the point at which the participant was first offered a choice of toys to play with. The 15-minute section of video that was scored had audio tones added to the recording every 15 seconds, using digital editing. Data was entered directly onto computer.

### **3.9.6. Baseline**

During the baseline phase of the study, the general procedures for child-led play (Appendix C) were followed. Once a toy had been selected by the participants, it was placed within reach in order for them to be able to play with it. In the baseline phase, participants were initially seen daily for a minimum of three consecutive days to establish a stable baseline. Once a baseline had been established, they were seen weekly until the start of intervention.

### **3.9.7. Intervention**

During the intervention phase of the study, the general procedures for child-led play were again followed (Appendix C). However, toys were placed out of reach of the participants and

the non-powered mobility programme was implemented using the prompt hierarchy (Appendix D) to facilitate the movement of the participant towards the toys in order to play with them. The development and structure of the non-powered mobility programme is described in detail in Section 4.2. The programme used a prompt hierarchy and provided a structured procedure for developing the motor skills required for mobility when using a non-powered mobility device. The non-powered mobility programme required two motor skill components. The first component involved the initiation of movement and was conducted on the ramp so that a greater effect of initiation of movement could be seen by the participant. The second motor skill component involved the continuation of movement and was conducted on the floor. Each component included a teaching criterion to be achieved over four sessions. During the intervention phase each participant was seen daily for eight days.

#### **3.9.8. Post-intervention**

On attaining the teaching criteria of the non-powered mobility programme, each participant entered the post-intervention phase of the study. During this phase, play was implemented in accordance with the general procedures (Appendix C), and as in the intervention phase, toys were placed out of reach of the participants. The prompt hierarchy was not applied during the post-intervention phase, but, if the participant initiated a movement independently and was unsuccessful, then forward chaining was provided to complete the movement. During the post-intervention phase of the study participants were seen weekly. The post-intervention phase was continued until all participants had completed a minimum of one post-intervention session. Due to various reasons not all participants completed their post-intervention sessions, and as such there was not sufficient data for the analysis of this, hence the post-intervention sessions are not reported on.

### **3.9.9. Data collection procedures**

The video equipment and intervention area were set up on a daily basis and filming begun prior to the participant entering the intervention setting. The cameras for filming were positioned so as to obtain footage from the entire therapy area. All cameras filmed from the same angle. A probe test was conducted on every video recording with each participant to collect data on their engagement.

The baseline phase was conducted over at least three consecutive days for all of the participants in the study. Once the baseline phase had been completed, Participant 1 commenced with the intervention phase, while the remaining three remained in baseline and were seen once weekly for baseline probes. As participant 1 began to attempt the second teaching criterion (motor skill component 2), so Participant 2 began the first teaching criterion (motor skill component 1), and the remaining two participants remained in the baseline phase. As Participant 2 achieved the second teaching criterion (motor skill component 2), so participant 3 moved on to intervention with the first teaching criterion (motor skill component 1), and as Participant 3 achieved teaching criterion 2 (motor skill component 2), so Participant 4 began with teaching criterion 1 (motor skill component 1). Following the completion of the intervention phase, participants were seen once weekly for post-intervention probes.

The study took a total of seven weeks for all participants to complete the intervention phase and at least one post-intervention session. For Participant 1, 17 sessions were conducted over a period of 35 days. For Participant 2, 15 sessions were conducted over 35 days. For Participant 3, 14 sessions were conducted over 35 days and for Participant 4, 15 sessions were conducted over 30 days. (Participant 4 fell ill at the start of the study and as a result began his baseline five sessions late.) Differences in sessions were as a result of extraneous variables

such as the participants themselves falling ill, their caregivers being ill, the need for keeping clinic visits and a caregiver writing exams.

### **3.10. Data analysis**

After the completion of the study, the data was graphed and compared using visual graphic analysis. Visual graphic analysis provides a comparison between subjects (Brown, Mcguire, Beck, Peterson, & Mooney, 2007). With a small sample size, visual graphic analysis is preferable to statistical analysis, which would infer predictions based on an entire population. Other benefits of visual graphic analysis include the fact that the graphic representation allows for and encourages the analysis of results by the reader, rather than the latter being dependent on statistical conclusions. A final benefit is that due to individual graphing, no results are either over- or under-estimated (Gast & Spriggs, 2010).

Nonetheless, statistical analysis was also used, as it would support visual analysis and provide improved objectivity, precision and certainty to visual analysis. Statistical analysis provides an effect size for the changes observed as well as confidence intervals (85%) to support this. The use of statistical analysis is particularly relevant where there is high variability in the data, which makes visual analysis challenging (Parker, Vannest, & Brown, 2009). For this study, the percentage of non-overlap of all pairs (NAP) was calculated using NCSS software (Hintze, 2006).

The NAP is an index of overlap that is used to determine effect size, and it has been shown to have good accuracy, greater efficiency of calculation and external validation against the Pearson's  $R^2$  and visual analysis judgments. It is preferred to older indices such as the Percentage of Non-overlapping Data (PND) and the Percentage of data points Exceeding the Mean (PEM), which have been shown to have weak performance (Parker, Vannest, & Davis,

2011; Parker & Vannest, 2009). The NAP is comparable to the percentage of all non-overlapping data (PAND), which is more accurate than the NAP but does not have the strength of external validity (Parker & Vannest, 2009).

The NAP compares each data point in the baseline phase with each data point in the intervention phase for overlap. It can be calculated by hand, but in order to determine confidence intervals, it is calculated directly as the percentage of area under the curve (AUC) from the Receiver Operating Characteristic (ROC) analysis. An empirical approach was used as this does not rely on the data being normally distributed (DeLong, DeLong, & Clarke-Pearson, 1988). For engagement scores the NAP comparison was conducted using a high x positive test direction (an improvement in engagement indicated a positive result). For non-engagement scores the NAP comparison was conducted using a low x positive test direction (a deterioration in non-engagement indicated a positive result).

Confidence intervals (CI) for the NAP results were also determined using the NCSS (Hintze, 2006) ROC analysis. CI's provide an indication of the certainty with which the effect size could be regarded as true.

### **3.11. Reliability**

Reliability in a study provides evidence that both the data collection and the procedural integrity of the study were maintained, such that the study is repeatable either at another time by the same researcher or by an independent person.

The raters used for inter-rater reliability were a physiotherapist and an occupational therapist, registered with the Health Professions Council of South Africa. Both had previous experience providing therapy to children with severe motor impairment. One of the raters was a physiotherapist who was trained in neurodevelopment and worked in a school for children with

physical disabilities. The other was an occupational therapist who worked in a paediatric private practice and was in the process of completing a further diploma in hand functioning. The raters were trained in the scoring of the ICER-R (Kishida & Kemp, 2006) during the pilot studies.

### **3.11.1.Data collection reliability**

A portion of the total number of sessions was scored for reliability during both the pilot and the main studies. Sessions to be scored were randomly selected by one of the independent raters using an internet-based random number generator. Altogether 30% of baseline sessions, 25% of intervention sessions from the main study were selected. This meets the recommendation by Schlosser (2005) that between 20% and 40% of sessions be scored for procedural integrity. Only two participants completed all their post-intervention sessions, and as a result the data from this phase was not able to be used. Consequently only 12,5% of post-intervention sessions were scored for reliability.

In the determination of the reliability of data collection various strategies are reported, these include point-by-point and statistical analysis. Although commonly used, point by point rating, which results in a percentage agreement of raters, has weakness, particularly where a limited number of options are available. The first is that where a large number of determinations are made in rapid succession (as with engagement using the ICER-R - 60, every 15 seconds), the likelihood of one rating being "missed" and the sequence being disrupted is high, which results in inaccuracy. In such circumstances the use of statistical measures is preferred (Cohen, 1968). Various methods of statistical analysis for such circumstances have been derived, for this study the Wilcoxon one sample test was used for intra-rater reliability. The Wilcoxon one sample test takes into consideration the deviation of each point, and then ranks them before calculating for statistical significance. For inter-rater reliability the Kruskal-

Wallis test was used as there were three scores for comparison. The Kruskal-Wallis test takes into account the number of observations and the rank of each score in the calculation of significance.

#### **3.11.1.1. *Intra-rater reliability***

Intra-rater reliability was assessed through re-scoring of sessions by the researcher, using the ICER-R (Kishida & Kemp, 2009), one month after the completion of the experimental phase of the study (see Section 4.3). The raw intra-rater reliability data for the randomly selected sessions is presented in Table 3.5 with the means, medians and statistical analysis in Table 3.6.

Table 3.5: Scores for intra-rater reliability for engagement and non-engagement

Participant Session	Scores														
	1	1	1	1	1	2	3	3	3	3	4	4	4	4	
	1	3	7	11	12	13	11	2	19	22	8	9	20	35	
Engagement	Researcher rating 1	37	29	35	44	45	48	36	12	8	41	36	28	43	53
	Researcher rating 2	40	31	36	46	48	50	36	31	6	40	40	29	41	54
Non-engagement	Researcher rating 1	22	31	24	16	13	12	20	47	52	17	24	31	17	7
	Researcher rating 2	20	29	23	14	12	10	20	29	54	18	20	30	19	6

Table 3.6: Intra-rater reliability for engagement and non-engagement

	Engagement				Non-engagement			
	Mean	Median	Standard deviation	p value*	Mean	Median	Standard deviation	p value*
Researcher rating 1	35.86	37	13.18	0.096	23.43	21	13.16	0.096
Researcher rating 2	36.21	37	13.01		23.07	21	12.98	

\* *p* is significant at a 5% level

Table 3.6 reveals the means (35.86, 36.21) and standard deviations (13.18, 13.01) on engagement, and the means (23.43, 23.07) and standard deviations (13.16, 12.98) on non-engagement for the first and second scorings respectively. The Wilcoxon One-sample Test yielded no statistical difference ( $p = 0.096$ ) in the results from the first to the second scoring by the researcher. These results indicate that the scoring of the researcher was reliable.

### **3.11.1.2. *Inter-rater reliability***

Inter-rater reliability was determined by comparing the scores obtained on the ICER-R (Kishida & Kemp, 2009) by the researcher and two independent raters who each used the ICER-R (Kishida & Kemp, 2006). The raw inter-rater reliability data is presented in Table 3.7, with the means, medians and statistical analysis in Table 3.8.

Table 3.7: Scores for inter-rater reliability for engagement and non-engagement

Participant Session	1			1			2			3			4		
	1	3	7	11	12	13	11	2	19	22	8	9	20	35	
Engagement	Researcher	37	29	35	44	45	48	36	12	8	41	36	28	43	53
	Inter-Rater 1	44	35	53	49	47	56	56	31	14	11	48	36	51	52
	Inter-Rater 2	39	36	51	48	46	54	51	15	10	40	45	33	43	49
Non-engagement	Researcher	22	31	24	16	13	12	20	47	52	17	24	31	17	7
	Inter-Rater 1	16	21	6	11	13	4	0	29	46	49	12	24	9	8
	Inter-Rater 2	21	24	9	12	13	6	6	45	49	20	15	27	17	11

Table 3.8: Inter-rater reliability for engagement and non-engagement

	Engagement			Non-engagement		
	Mean	Median	p value*	Mean	Median	p value*
Researcher	40	44	0.1968	19.64	16	0.2061
Inter-rater 1	41.64	47.5		17.71	14.85	
Inter-rater 2	35.36	36.5		23.79	21	

\* *p* is significant at a 5% level

Table 3.8 reveals the means (40.00, 41.64, 35.36) on engagement and non-engagement (19.64, 17.71, 23.79) for the researcher and the two raters respectively. The Kruskal-Wallis test for the inter-raters yielded no statistically significant difference ( $p = 0.1968$ ,  $p = 0.2061$ ) for engagement and non-engagement respectively. This indicates consistency in the scoring of the researcher in comparison to the independent raters.

### **3.11.2.Procedural reliability**

The procedural reliability of firstly the general procedures and, secondly, adherence to the prompt hierarchy was evaluated by the researcher and an independent rater. They scored a portion of randomly selected sessions, 30% of baseline sessions, 25% of intervention sessions and 12,5% of post-intervention sessions (Kratochwill et al., 2012). For all sessions, the raters independently scored adherence to general procedures using the score sheet (Appendix C) and the prompt hierarchy using the checklist (Appendix D). The percentage of correctly applied procedures was calculated for each session ( $[\text{correct tallies}/\text{Total number of tallies}] \times 100$ ). These percentages were compared using the Wilcoxon Two-sample Test to determine if there was any statistically significant difference. Table 3.9 presents the raw data for procedural integrity while Table 3.10 provides the results of the statistical analysis.

Table 3.9: Procedural reliability percentages for general procedures and the prompt hierarchy

Participant		1	1	1	1	1	2	3	3	3	3	4	4	4	4
Session		1	3	7	11	12	13	11	2	19	22	8	9	20	35
General procedures	Researcher	91.3	97.67	81.58	96.55	95.24	91.89	89.29	97.83	88.89	100	100	92	100	95.56
	Inter-Rater 1	100	98.21	100	95.45	92	94.12	83.87	100	86.36	90.57	96	100	91.55	77.55
Prompt hierarchy	Researcher			92.16	95.19	94.03	96.2	93.1		100	90.91				
	Inter-Rater 1			90.91	100	98.33	94.94	97.22		100	94.12				

Table 3.10 Procedural reliability for general procedures and the prompt hierarchy

Procedures	General procedures - Mean	Prompt hierarchy procedures - Mean
Researcher	93.26%	96.50%
Inter-Rater 1	94.13%	94.52%
p-value*	0.9466	0.2475

\* *p* is significant at a 5% level

The procedural reliability scores for both general procedures and the prompt hierarchy are between 93 and 97%, indicating high integrity (Perepletchikova & Kazdin, 2005). In addition, no statistically significant difference between the inter-raters was found.

As indicated in Table 3.10, the mean for the inter-raters on the general procedures was 93,2% and 94,13% for raters 1 and 2 respectively. The Wilcoxon Two-sample Test yielded no significant difference ( $p = 0.9466$ ) in the general procedures scores of the inter-raters. The mean for the inter-raters on the prompt hierarchy was 96,5% and 94,5% for raters 1 and 2 respectively. The Wilcoxon Two-sample Test yielded no significant difference ( $p = 0.2475$ ) in the prompt hierarchy scores of the inter-raters.

### **3.12. Summary**

This chapter provided an overview of the methodology employed in the study. The aims of the study and the design were specified. To begin with, sub-aims (i) and (ii) of the study were addressed in the pilot studies and recommendations arising out of these were discussed. Sub-aim (iii) was addressed as participant recruitment was outlined and a description of each participant was provided. This was followed by a description of the materials and equipment for the study and an explanation of the procedures used during the baseline, intervention and post-intervention phases. Data collection and analysis were specified and explained. The chapter concluded with an explanation of the analysis of the results for both data and procedural reliability.

## CHAPTER 4: MATERIAL DEVELOPMENT

### 4.1. Introduction

This chapter provides an overview of the materials used in this study. Firstly, the theoretical orientation and principles of the non-powered mobility programme are described and discussed. This is followed by a description of the development of the programme, including its components and the materials used. The selection process for the ICER-R (Kishida & Kemp, 2009) as the measure of the dependent variable, engagement, is described next and the chapter concludes with a description of the processes used in the translation of materials.

### 4.2. Development of the non-powered mobility programme

This section describes the development of the non-powered mobility programme, which is the independent variable for this study. The programme was applied to children with severe motor impairment using the non-powered, self-initiated mobility device described in Section 3.8.1.5.1.

The development of the non-powered mobility programme was conducted over eight steps. The *first step* involved a review of the theories of motor skill development and resulted in the identification of two main theories, namely motor control theory and motor learning theory. The *second step* considered the application of these theories to children with severe motor impairment within a structured programme. Due to challenges in the application of motor learning theory to children with severe motor impairment, motor control theory was selected for use in the non-powered mobility programme. *Step three* involved the analysis of the components of movement on the non-powered, self-initiated mobility device and two components were identified: i) the initiation of movement and ii) the continuation of movement. *Step four* identified the procedures to be used for motor skill development, which were then combined in a prompt hierarchy. *Step five* involved the development of the general procedures for conducting the non-powered mobility

programme. The general procedures pertaining to choice making and play were outlined for the non-powered mobility programme and toys for its application were identified. *Step six* comprised the identification of a teaching criterion for the non-powered mobility programme, while *step seven* focused on the development of the procedural scripts for both general procedures and the prompt hierarchy, to be used in the implementation of the non-powered mobility programme. The final step in the development of the non-powered mobility programme was the identification of mechanisms through which the effect of the programme could be measured.

The detailed steps followed in the development of the non-powered mobility programme are next summarised in Table 4.1.

*Table 4.1: Development of the non-powered mobility programme*

Step	Aim	Theoretical rationale	Procedure	Result
1.	To identify theory on motor skill development.	Existing mobility training programmes focus on the skills required to drive a powered mobility device, whereas the use of a non-powered device requires a focus on motor skill learning.	Conducting a literature review on motor skill development theories.	A review of the literature: two theories, namely motor control theory and motor learning theory were identified. The process of identifying these theories is outlined in Section 4.2.1.
2.	To determine the motor skill learning theory applicable to children with motor impairment in a structured programme.	For children with motor impairment, development does not progress as anticipated; hence the motor skill theory to be applied must provide for opportunities for learning beyond typical experience.	Analysing the motor skill theories in terms of the following criteria: <ul style="list-style-type: none"> <li>- Application to children with mobility impairment</li> <li>- Implementation within a structured programme</li> </ul>	Motor control theory is applicable to children with motor impairment and should be implemented in a structured programme. Motor control theory was therefore elected for use within the non-powered mobility programme (see Sections 4.2.2 and 4.2.3).
3.	To analyse the components of movement required for mobility using the scooter board.	Mobility is a composite skill made up of numerous elements. The deconstruction of mobility into individual components allows for each component to be worked on individually (Valvano, 2004).	Analysing the components of mobility on a scooter board and obtaining confirmation from another therapist.	The components of mobility as required on a scooter board were identified as: <ul style="list-style-type: none"> <li>- Initiation of movement</li> <li>- Continuation of movement (Section 4.2.3)</li> </ul> The components were confirmed by a physiotherapist with neurodevelopmental training.
4.	To identify strategies that could be used teaching motor skills in the non-powered mobility programme.	Willingham (1998) described the motor control processes associated with motor skills learning, which include the use of cognitive, sensory and communication elements for both explicit and implicit learning.	Considering motor skills teaching for children with motor impairment, and identifying strategies for teaching motor skills.	The following strategies were identified for the teaching of motor skills (Section 4.2.4): <ul style="list-style-type: none"> <li>- Verbal input</li> <li>- Chaining</li> <li>- Prompting</li> </ul>
5.	To develop the general procedures for the non-powered mobility programme, identify materials for this and write procedural scripts.	The general procedures for the non-powered mobility programme provide the goals for the motor control processes as described by Willingham (1998). Goals need to be motivating – for young children these can be provided in the context of play.	Determining the specific steps required in each session with each participant. Identifying toys for use in the programme that would encourage mobility but have a low cognitive load. Writing a general procedures script for each	Each session was identified as requiring a welcome, toy choosing, ongoing play, play conclusion and session conclusion. The toys for use in play were identified and the play procedures for each were outlined (Section 4.2.5). Toys included a soccer ball, skittles, cars, trains, bubbles and a music ball. The specific procedural scripts for each part of the session were written. (Appendix C).

Step	Aim	Theoretical rationale	Procedure	Result
6.	To determine teaching criteria for the programme.	The purpose of an intervention programme is represented in the criteria set. These are clearly defined goals based on the constructs identified in the literature (Benson & Clarke, 1982; Scientific Advisory Committee of the Medical Outcomes Trust, 2011).	step. Determining the time necessary for a child to achieve each of the mobility components.	Four sessions per component were required for achieving the set teaching criterion (Section 4.2.6).
7.	To write procedural scripts for the implementation of the prompt hierarchy.	For the programme's efficacy to be measured, such a programme needs to be implemented reliably. Procedural scripts provide a structure that can be followed and allow for integrity to be measured.	Writing a detailed script for the implementation of the prompt hierarchy, including the required physical and verbal input.	A procedural script was written. (Appendix D).
8.	To determine the manner in which the effect of the non-powered mobility programme can be described.	In order for the efficacy of a programme to be determined the effect of this must be described.	Exploration of mechanisms which described the effect of the programme.	Qualitative mechanisms of description including body parts used, type of movement, and ability to move across the intervention area were identified.

#### 4.2.1 Step 1: Identification of theories on motor skill development

In order to determine the most appropriate strategies for developing the motor skills of children with severe motor impairment, physiotherapy literature was consulted. However, as highlighted in reviews by Horn(1991), Anttila, Autti-Rämö, Suoranta, Mäkelä, and Malmivaara (2008) and Franki et al. (2012), studies on the efficacy of physiotherapy treatments for children with cerebral palsy are lacking in scientific strength. Furthermore the studies presented in the reviews were for the most part descriptions of specific techniques or programmes, rather than theoretical models which were implemented. Due to this a search was conducted to identify theories of motor skill training for children. The following search engines were used: Academic Search Premier, CINAHL, E-Journals, ERIC, Health Source – Nursing/Academic edition, Humanities Source, Masterfile premier, Medline and TOC Premier. The descriptors that refined the search included *motor skill learn\**, *train*, *theory*, *child\**, *cerebral palsy*, *disab\* measure\**, *child\** and *not autism\**. Only texts written in English were considered. The search engines registered 112 texts. Each was considered based on the criterion of providing a theoretical basis for motor skill development for young children with severe motor impairment. The titles of the texts were read and 95 texts were omitted as they did not meet these criterion. For the remaining 17 articles, the abstract of each text was read and the exclusionary criteria applied. Five texts were excluded as they were intervention studies that did not provide a motor skill theory foundation; two as they were not related to motor skill development; and eight as they were not related to young children with severe motor impairment; . The contribution of the remaining seven texts is summarised in Table 4.2. From these articles, a further hand search was conducted for additional information and this identified a further three texts. The additional texts are also represented in Table 4.2.

Table 4.2 Articles identified in the literature search on motor skill learning theories

Author (year)	Title of text	Motor skill learning theory:	Population	Basis of theory	Applied to children with motor impairment?	Search type
Newell, (1991)	Motor skill acquisition theory	All	N/A	Multiple theories on motor skill learning are presented and compared.	Yes, theoretically	Hand – from Snapp-Childs, Casserly, Mon-Williams, & Bingham, (2013)
Horn (1997)	Achieving meaningful motor skills: conceptual and empirical bases of a neurobehavioral intervention approach	Motor control theory	Children with cerebral palsy	The goal of motor intervention is the demonstration of functional skills in meaningful activities. Learning, social interaction and experience are of key importance for motor development.	Yes: 11 toddlers (7-34 months) with cerebral palsy were provided with intervention based on motor control theory. The components of movement and exemplar skills introduced in the intervention were assessed. Both components and exemplar skills showed an improvement with the intervention.	Literature
Steenbergen, van der Kamp, Verneau, Jongbloed-Pereboom, & Masters (2010)	Implicit and explicit learning: applications from basic research to sports for individuals with impaired movement dynamics	Motor control theory	Children and adults with impaired motor functioning	Motor skills can be learnt implicitly or explicitly. Explicit learning places demands on working memory, which can be circumvented by implicit learning.	Yes, theoretically the processes of motor control theory are applied to limited results of existing studies.	Literature
Willingham (1998)	A neuropsychological theory of motor skill learning	Motor control theory	Typically developing and neurologically impaired populations	Three motor control processes may be able to improve performance: selecting spatial targets for movement, sequencing the targets and transforming them into muscle movement. A fourth target of selecting more effective goals can also assist in motor learning	Yes: Theoretically in Steenbergen et al. (2010) presented above.	Hand – from Steenbergen et al. (2010)

Author (year)	Title of text	Motor skill learning theory:	Population	Basis of theory	Applied to children with motor impairment?	Search type
Pick (2003)	Development and learning: an historical perspective on acquisition of motor control	Motor control theory	N/A	There is reciprocal influence between development and experience in motor performance.	No	Literature
Gabbard (1984)	Motor skill learning in children	Motor learning theory	Young children	Practising a variety of movement outcomes will enhance the schema for that movement.	No	Literature
Schmidt (1975)	A schema theory of discrete motor skill learning	Motor learning theory	N/A	A schema using recall memory is used to produce movement. Recognition memory then evaluates the movement for accuracy.	No	Hand – from Newel; (1991)

In Table 4.2, two areas of motor skill theory applicable to young children with severe motor impairment are evident, namely motor control and motor learning. The texts identified provide a detailed theoretical basis for each theory, however the clinical application of the theories is limited. Only motor control theory has been applied to children with motor impairment in the study by Horn (1997) which considered the effect of a neurobehavioral programme on the acquisition of specific movements and the generalisation of these in toddlers with cerebral palsy. This study however is not presented in sufficient detail for analysis.

The two theoretical foundations described are discussed below. Motor control has as its goal the performance of functional skills. According to motor control theory, development occurs through both unconscious (implicit) and conscious (explicit) learning (E. M. Horn, 1997). The process of development within motor control theory begins with the selection of a goal. This is a change that needs to be made in the environment and it can be consciously or unconsciously chosen. Following goal selection is goal identification, where the focus of the goal is identified, e.g. close the window – the handle on the window is the focus. Following goal identification, the target body part to perform the goal is selected – consciously or unconsciously. The target is then sequenced through the movements required for the goal to be accomplished (both consciously or unconsciously) and the muscle is activated. For motor skill development, repetition is added to this process in order for it to become more refined (Willingham, 1998). The process of motor skill development as represented by the motor skill theory is represented in Figure 4.4 below.

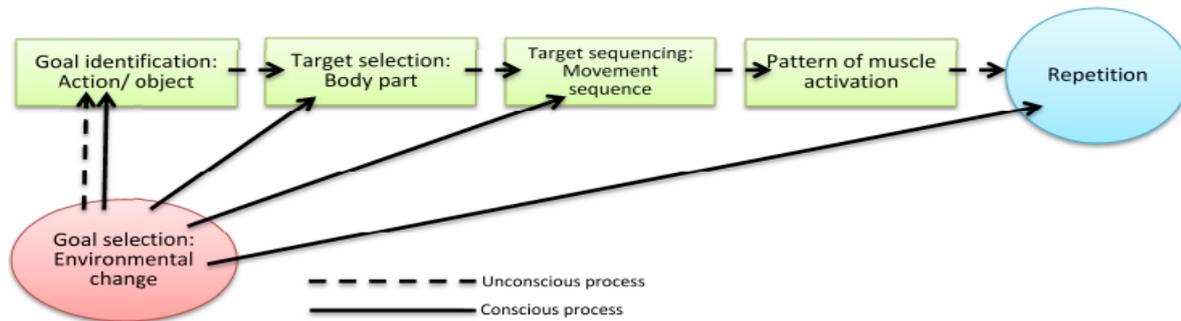


Figure 4.4: Schematic representation of motor control theory adapted from Willingham (1998, p. 561)

Motor learning, in contrast to motor control, is primarily an unconscious process which relates specifically to the learning of a motor skill, rather than achieving a functional goal. Within motor learning theory; each time a movement is made; four types of information are stored: the initial conditions, specifications for the motor programme, sensory consequences and outcome of the movement. Once the movement has been performed a number of times, this information is (unconsciously) analysed for relationships between the four areas. The results of the analysis, which are stored in the schema and are strengthened the more often the movement is performed, affect future performance of that movement and make it more successful. The only conscious contribution to learning within motor learning theory is the judgment of the success of the outcome, which is added to the analysis of information. For instance, in soccer, a kick would be determined successful if it went in the correct direction at the correct speed (Schmidt, 1975). For the majority of movements, however, an outcome is not consciously determined – e.g. picking up a cup. Even if the cup is dropped or missed, a conscious thought process relating to the movements required is not usually entertained (Schmidt, 1975). The process of motor skill development as represented by motor learning theory is represented in Figure 4.2 below.

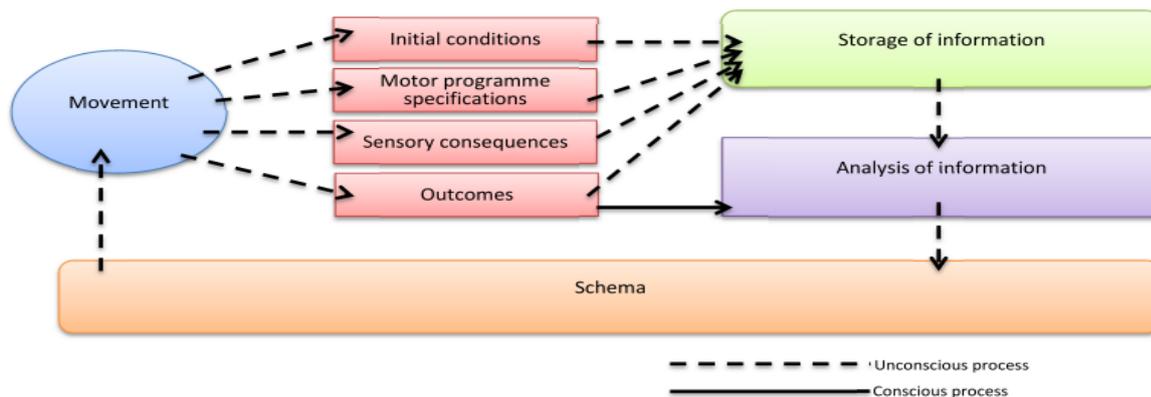


Figure 4.2: Schematic representation of motor skill development as represented by motor learning theory (Schmidt, 1975)

#### 4.2.2 Step 2: To determine the applicability of the theories to children with motor impairment

The motor control and motor learning theories were analysed based on their applicability to children with severe impairment, and their application in a structured programme.

##### 4.2.2.1 Application to children with motor impairment

Of the motor control and motor learning theories, only motor control theory has been applied to children with disabilities. Horn (1997) presents this application in her article on the learning of specific movements, however as discussed above, the detail provided on this study is limited. On a theoretical basis however both Steenbergen et al. (2010) and Willingham (1998) have provided examples of the application of motor control theory to children with cerebral palsy. Each of these authors highlights the benefit of explicit learning strategies where implicit learning has not progressed as anticipated, as is the case with cerebral palsy.

In relation to motor skill learning for children with motor impairment: deficits relating to additional impairments such as sensory, cognitive or physical impairment are common (Odding, Roebroek, & Stam, 2006; Steenbergen et al., 2010; Willingham, 1998). Such deficits can result in

difficulty in “finding the correct movement” (sensory deficits), retaining the movement in memory (cognitive deficits), and repeating the movement (physical deficits). These deficits as viewed in relation to motor learning theory result in incorrect or incomplete schema formation, in that the sensory consequences recorded may be incomplete, the motor programme specifications complex and the outcomes poor, thus implying a negative impact on motor skill learning. In contrast, the explicit processes within motor control theory allow for the replacement of areas in which there are deficits with alternative input. For instance, a memory deficit could be limited through the use of ongoing visual and verbal input (Willingham, 1998). Due to the challenges in the application of motor learning theory to children with motor impairment and the existing application of motor control theory to children with motor impairment, motor control theory was preferred to motor learning theory.

#### ***4.2.2.2 Application in a structured programme***

As specific intervention is required for children with motor impairment, the selected motor skill theory must be able to be applied in a structured programme in which progress can be measured. Motor control theory as presented by Willingham (1998) is described in a clearly defined task-orientated programme that provides opportunities for both implicit and explicit learning, as represented in Figure 4.4 above. For this reason, motor control theory was preferred to motor learning theory for the non-powered mobility programme.

#### **4.2.3 Step 3: Analysis of the components of movement**

The movements required for mobility using a scooter board were analysed and confirmed by a physiotherapist. The analysis and classification of movement into underlying components rather than individual movements prevents the focus from becoming too limited at the movement level

and allows for improved functional skill development (E. M. Horn, 1997). The motor skill components identified were the following:

- i. Initiation of movement: to be taught on a ramp to increase the effect of initiation
- ii. Continuation of movement: to be taught on a flat floor

#### **4.2.4 Step 4: Identification of the motor skill teaching strategies**

Motor skill teaching strategies for children with cerebral palsy were reviewed by Horn in 1991. The review identified both verbal input and chaining as implementation strategies, although it must be noted that an overall absence of well-defined strategies was found. Each of the strategies was then considered in relation to the motor skill processes outlined by Willingham (1998). The application of the strategies to motor skill processes highlighted the fact that the strategies were not exclusive and hence a prompt hierarchy was developed for the strategies to be applied in a structured and systematic manner.

##### ***4.2.4.1 Verbal input***

Verbal input includes the provision of instructions and feedback. Instructions provided prior to a movement are considered a verbal prompt, while those provided following a movement are considered feedback. All verbal feedback must be specific, limited to the key elements of the movement and timeous (Larin, 1998) (Appendix D).

##### ***4.2.4.2 Chaining***

Chaining is an errorless motor learning strategy that has greater efficacy than whole movement learning in the presence of brain dysfunction (Connor, Wing, Humphreys, Bracewell, & Harvey, 2002; Greenberg, 2010). In chaining, each element of a movement is taught and applied sequentially. Chaining can be conducted forwards or backwards. Forward chaining has been shown to be more effective, for complex sequences of movements, than backward chaining

(Welsh, Fitt, & Thompson, 1994), while backward chaining has been shown to provide greater motivation than forward chaining, because the completion of the movement leads to the immediate realisation of the goal. Due to the links between severe motor impairment and motivation (Section 2.3.4), backward chaining was used in this study.

#### 4.2.4.3 Prompting

Verbal input and chaining are not exclusive but complementary strategies. However, for motor skill teaching to lead to independence using these strategies, the input provided must be reduced as the participant becomes more competent until it is no longer required. The process of reducing support in a structured manner has been termed a “prompt hierarchy”. For the current study, a ‘least-to-most’ prompt hierarchy was selected (McDonnell & Ferguson, 1989). In a least-to-most prompt hierarchy, input (verbal or tactile) is provided at the lowest possible level, and escalates to higher levels only when the participant is unable to respond. Such a hierarchy encourages independence through the provision of only the minimum input for success on each attempt (McDonnell & Ferguson, 1989). The application of the prompt hierarchy with each of the strategies is represented in Table 4.3.

Table 4.3 Prompt hierarchy for the facilitation of movement

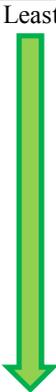
Motor skill process	Strategy	Prompt level	Action	Example
Goal identification	Verbal input	 Least	Verbal input	“Pop the bubbles”; “Push it, it will play a song”
Target identification	Verbal input		Verbal input	“Push on your hands”
	Chaining		Light touch	A gentle tap to the toes
Target sequencing	Verbal input and chaining		Light touch and verbal	(A gentle tap to the toes) “Here”; “Push off your toes”
	Verbal input and chaining		Verbal input and body part placement	The foot is placed vertically and with the ankle at 90 degrees so that the toes are touching the ground. “Push on your toes”
Repetition	Verbal input and chaining	Verbal input with chaining (backward)	The foot is facilitated through the movement until the final component, which the child is encouraged to produce independently.	
	Verbal input	Most	Verbal input	“Let’s do it again.”

Table 4.3 presents the application of Willingham's motor control processes as used for the non-powered mobility programme, based on a prompt hierarchy (McDonnell & Ferguson, 1989). Each process is identified and the strategy to be used is named. The prompt level from least to most is then indicated, followed by a description of the action and an example of its application.

#### **4.2.5 Step 5: To determine the general procedures for the mobility intervention programme**

Motor control theory and the processes described by Willingham (1998) have the goal of the performance of functional skills. For young children, play is a primary mechanism in which functional skills are practised and learnt (Brodin, 1999; Irwin, Siddiqi, & Hertzman, 2007; Piaget, 1964; Vygotsky, 1978). Hence the non-powered, self-initiated mobility intervention programme was based on play. The general procedures for this programme however also included the specification of strategies for welcoming the participants into the therapy setting, selecting the toys for play, maintaining play in a consistent manner, concluding play and concluding the session in order to ensure that participants were given consistent input throughout. Scripts were written for each of these areas, including for verbal and physical input (Appendix C).

Seeing that the current study measured engagement in play, toys were required. Since children with motor impairment often find play challenging (Brodin, 1999), the toys that were selected had to offer a strong reward that would motivate the participants to give of their best (Bartlett & Palisano, 2002; Majnemer et al., 2010; Majnemer, 2011). In addition, due to the fact that this study considered the effect of the mobility device on engagement, toys with a low cognitive load were selected to prevent changes in engagement being related to learning from the toys rather than to mobility itself. The following toys were selected for the programme and used as indicated:

- Skittles: pushed over
- A music ball: pushed and chased
- A soccer ball: pushed and chased
- Cars: pushed and chased
- Trains: pushed and chased
- Bubbles: popped and chased

The specific toys used and a brief description of the manner in which they were played with are shown in Table 4.4.

Table 4.4: Toys for the non-powered mobility programme

Toy	Play description	Toy	Play description
 <p>Skittles</p>	<ul style="list-style-type: none"> <li>• The skittles are put out, standing up.</li> <li>• The participant knocks over the skittles, using hands, legs, head or the scooter board.</li> </ul>	 <p>Music ball</p>	<ul style="list-style-type: none"> <li>• The participant pushes the ball or one of the pictures on the ball so that the ball plays a tune.</li> <li>• The ball rolls away while playing the tune and participants chase it to start the tune again.</li> </ul>
 <p>Soccer ball</p>	<ul style="list-style-type: none"> <li>• The participant pushes a soccer ball towards the researcher/ the caregiver, using hands, legs, head or the scooter board .</li> </ul>	 <p>Bubbles</p>	<ul style="list-style-type: none"> <li>• A battery-operated bubble blower is used to make bubbles.</li> <li>• The bubbles are popped by the participant.</li> <li>• The bubbles are chased by the participant.</li> </ul>
 <p>Cars</p>	<ul style="list-style-type: none"> <li>• The participant pushes or pulls the cars.</li> <li>• The participant plays with the moving parts of the cars.</li> <li>• The participant chases after the car that is out of reach.</li> </ul>	 <p>Trains</p>	<ul style="list-style-type: none"> <li>• The train is pushed by the participant.</li> <li>• The participant chases after the train when it is out of reach.</li> <li>• Trains were used both on and off the track as determined by the participants.</li> </ul>

#### 4.2.6 Step 6: Determination of teaching criterion

A standard of four sessions (30 minutes) per motor skill component was set to achieve the teaching criterion. The first component, involving the initiation of movement was trained over four sessions and the second component, continuation of movement, over another four sessions. Hence, eight sessions in total were considered adequate to achieve the teaching goal.

#### **4.2.7 Step 7: Writing of prompt hierarchy procedural script**

A procedural script was written for the prompt hierarchy used in the non-powered, self-initiate mobility programme. This outlined the use of verbal input and chaining in a set structure in the prompt hierarchy. The procedural script is available in Appendix D.

The development of the non-powered mobility programme was concluded with the programme being piloted. The results of the pilot study have been discussed in Section 3.6.

#### **4.2.8 Step 8: Reporting of results from the non-powered mobility programme**

The aim of the non-powered mobility programme is the development of independent mobility for the participants using a non-powered, self-initiated mobility device. In order to provide evidence of efficacy of the programme, the measurement of the level of mobility which the participants achieved, was required. However, the measurement of mobility achieved during the programme through a measurement of distance covered was not possible due to a number of factors. The first factor was that of the use of the ramp during the first teaching criterion. Due to the lower motivation of children with severe motor impairment; as indicated in the literature on participation (Imms, 2008a; Voorman et al., 2006) and learned helplessness (Abramson et al., 1978); the process of learning self-initiated mobility needed to be highly motivating. Due to this the first criterion was conducted on a ramp. This resulted in any initiation of movement from the participants being translated into ongoing movement down the ramp. As such a measure of the distance moved was not possible, as much of the distance was as a result of the slope of the ramp. Secondly the use of the ramp during the first teaching criterion meant that the distance moved during the first teaching criterion could not be compared to that of the second, where the participants were on the flat floor. A Final challenge in the measurement of mobility during the

implementation of the non-powered mobility programme was that the programme was founded on the provision of prompting which included chaining, during which parts of the movement were facilitated for the participants, by the researcher. As such a measurement of mobility during the course of the intervention programme would have included mobility as a result of facilitation by the researcher. Due to the challenges mentioned above no quantitative measure of mobility was available for this research study. Instead observations of manner of propulsion and distance moved were made.

### **4.3. Selection of the tool for measuring engagement**

#### **4.3.1 Engagement definition**

As indicated earlier in Table 2.1 and also in Table 4.5 below, engagement refers to “the time children spend interacting with the environment in a developmentally and contextually appropriate manner” (McWilliam & Bailey, 1995, p. 123). In this study engagement refers to the measurement of the dependent variable.

#### **4.3.2 Engagement measures**

The measurement of engagement has been conducted in various ways since the introduction of the construct (Adamson et al., 2004; de Kruif & McWilliam, 1999; Kishida & Kemp, 2009; McWilliam & Bailey, 1990, 1995; Ridley, McWilliam, & Oates, 2000). A literature search was conducted to identify the measures available for assessing the engagement of young children. The search engines that were used included Academic Search Premier, CINAHL, E-Journals, ERIC, Health Source – Nursing/Academic edition, Humanities Source, Masterfile premier, Medline, TOC Premier and JSTOR. The inclusion criterion for the search were measures of engagement which were appropriate for the assessment of individual young children, with disabilities, but excluding autism. Descriptors that refined the search included *engagement, measure, assess, young*

*child\**, *disab\** and *not autis\**. This search rendered three articles. The first presented a measure of engagement for children with intellectual disabilities (Kishida & Kemp, 2006), the second was a revision of this measure (Kishida et al., 2008) and the third considered the reliability of observation as a method for measuring engagement in children. As engagement is a broadly used term used, other searches returned multiple articles of no relevance to this study (democracy, social engagement, learning programmes for older students/ adults, parental engagement and social media engagement). Due to this challenge, further hand searches of the literature were conducted with these three articles as the basis. From the hand search, a further four articles were identified. One was omitted as it made use of an already identified measure and therefore the original article on this measure was used. The measures identified are presented in Table 4.5.

*Table 4.5: Measures for the assessment of engagement in young children*

Author (year)	Aim	Engagement measure	Definition of engagement	Level of engagement	Population	Format	Method of measurement	Scoring	Result
Adamson, Bakeman, & Deckner (2004)	To determine how often symbols were used with young children and how this affected their language development.	The State-Based Coding System	A period of at least 3 seconds characterised by active interest in people, objects and events. Each engagement period is then categorised into one of 11 exclusive categories.	<ul style="list-style-type: none"> <li>•Unengaged</li> <li>•On-looking, Person</li> <li>•Object</li> <li>•Supported joint</li> <li>•Co-ordinated joint</li> <li>•Symbol only</li> <li>•Person symbol</li> <li>•Object symbol</li> <li>•Symbol-infused supported joint</li> <li>•Symbol infused co-ordinated joint</li> </ul>	56 typically developing children 18-30 months of age.	Individual	Data was collected from children in a joint attention activity with their mother. Coders of the data looked for changes in engagement state. They determined the level of engagement in each period.	The number of times each type of engagement was seen, was added up to produce 11 scores.	The amount of symbol-infused joint engagement may contribute to language development at 30 months.
Casey & McWilliam (2008)	To examine graphical feedback as a mechanism for enhancing the teaching of preschool teachers.	Engagement Quality and Incidental Teaching for Improved Education (E-Qual-ITIE)	Not defined	Teacher input: <ul style="list-style-type: none"> <li>•Incidental teaching</li> <li>•Non-elaborative responses</li> <li>•Non-responsive directives</li> </ul>	Children aged 22-64 months with mild-moderate disabilities.	Individual	The input a teacher provides to a class is identified every 15 seconds for a period of 20 minutes.	The number of times each type of input was noted during scoring is added up to produce three scores.	Teachers in all classrooms increased their incidental teaching when information on incidental teaching and graphical feedback were provided.
de Kruif & McWilliam (1998)	To explore patterns of relationships among developmental age, teacher rating of global engagement and observed engagement in a classroom	Engagement Quality Observation System III (E-Qual III)	The amount of time children spend interacting with the environment at different levels of competence (McWilliam & Bailey, 1992).	<ul style="list-style-type: none"> <li>•Persistence</li> <li>•Pretend</li> <li>•Participation</li> <li>•Undifferentiated behaviour</li> <li>•Attention</li> <li>•Non-engagement</li> </ul>	Preschool, typically developing and disabled (mild-moderately impaired) 9.5 to 63 months.	Individual	The level of engagement is identified every 15 seconds for 15 minutes. Data is recorded using a specialised computer system.	Computer scoring	A positive relationship was present between developmental age and high levels of engagement.

Author (year)	Aim	Engagement measure	Definition of engagement	Level of engagement	Population	Format	Method of measurement	Scoring	Result
	setting.								
Kishida & Kemp (2006)	To develop a measure of engagement that could be used with children with disabilities, specifically severe intellectual disabilities.	Individual Child Engagement Record (ICER)	The amount of time children spend interacting with the environment in a developmentally and contextually appropriate manner (R. A. McWilliam & Bailey, 1995).	<ul style="list-style-type: none"> <li>●Active engagement</li> <li>●Passive engagement</li> <li>●Un-engaged</li> <li>●Active non-engagement</li> <li>●Passive non-engagement</li> </ul>	Preschool children with moderate to severe developmental delays, 31-61 months in a preschool setting.	Individual	The level of engagement is identified every 15 seconds for 15 minutes. In addition, the focus of engagement (peer/ adult) and the presence of physical prompts can be recorded.	The number of times each type of engagement was seen was added up to produce four scores, one for each type.	The measure was able to determine the engagement of children with disabilities in activities and thus highlighted activities that provided better learning opportunities.
Kishida, Kemp & Carter (2008); Kishida & Kemp (2009)	To revise and validate the ICER.	Individual Child Engagement Record – Revised (ICER-R) (Kishida & Kemp, 2009)	The involvement of situationally appropriate interactions with the physical environment, materials, or other persons (Bailey & Wolery, 1992).	<ul style="list-style-type: none"> <li>●Active engagement</li> <li>●Passive engagement</li> <li>●Active non-engagement</li> <li>●Passive non-engagement</li> </ul>	Five children with a mean age of 46.2 months with severe cognitive impairment.	Individual	The level of engagement is identified every 15 seconds for 15 minutes. In addition, the focus of engagement (peer/ adult) and the presence of physical prompts can be recorded.	The number of times each type of engagement was seen was added up to produce four scores, one for each type.	The ICER-R (Kishida & Kemp, 2009) was found to be a valid and reliable measure of engagement for children with disabilities in early childhood settings.
McWilliam & Bailey (1995)	To examine the effects of disability, age grouping and adult involvement on engagement.	Engagement Check	The time children spend interacting with the environment in a developmentally and contextually appropriate manner.	<ul style="list-style-type: none"> <li>●Engaged with adult</li> <li>●Engaged with peers               <ul style="list-style-type: none"> <li>○ Interactional</li> <li>○ Attentional</li> </ul> </li> <li>●Engaged with materials</li> </ul>	Preschool, typically developing and mild/moderate cognitive impairment, 1- to 4-year-olds.	Individual	Data collection every 15 seconds for a period of 10 minutes. Scoring was conducted live.	Child was classified into one of nine areas of engagement.	Children with disabilities spent less time engaged with adults, peers and in mastery motivation with objects. Differences in

Author (year)	Aim	Engagement measure	Definition of engagement	Level of engagement	Population	Format	Method of measurement	Scoring	Result
				<ul style="list-style-type: none"> <li>○ Pre-mastery</li> <li>○ Mastery</li> <li>● Non-engaged</li> <li>○ Active</li> <li>○ Passive</li> </ul>					engagement for disabled and typically developing peers were evident.

In Table 4.5 above, the measures of engagement identified in the literature search were presented. Of the measures identified, the E-QUAL III (de Kruif & McWilliam, 1999), the E-QUAL-ITIE (Casey & McWilliam, 2008) and the Engagement Check (McWilliam & Bailey, 1995) were applied to children with mild-moderate disabilities. While the ICER-R (Kishida et al., 2008; Kishida & Kemp, 2006) was applied to children with severe impairments.

#### ***4.3.2.1 Review of the measures of engagement according to criteria***

Each of the engagement measures identified in Table 4.5 was considered for this study based on the need for individual assessment that is appropriate for children with severe motor impairment. Based on these criteria, the E-Qual III (de Kruif & McWilliam, 1995) and the ICER-R (Kishida & Kemp, 2009) were identified as meeting the criteria for possible measurement instruments. The measures were then compared based on their suitability for the current study. An illustration of the levels of engagement as presented in both the ICER-R (Kishida & Kemp, 2009) and the E-Qual III (de Kruif & McWilliam, 1999) is presented in Figure 4.3 below.

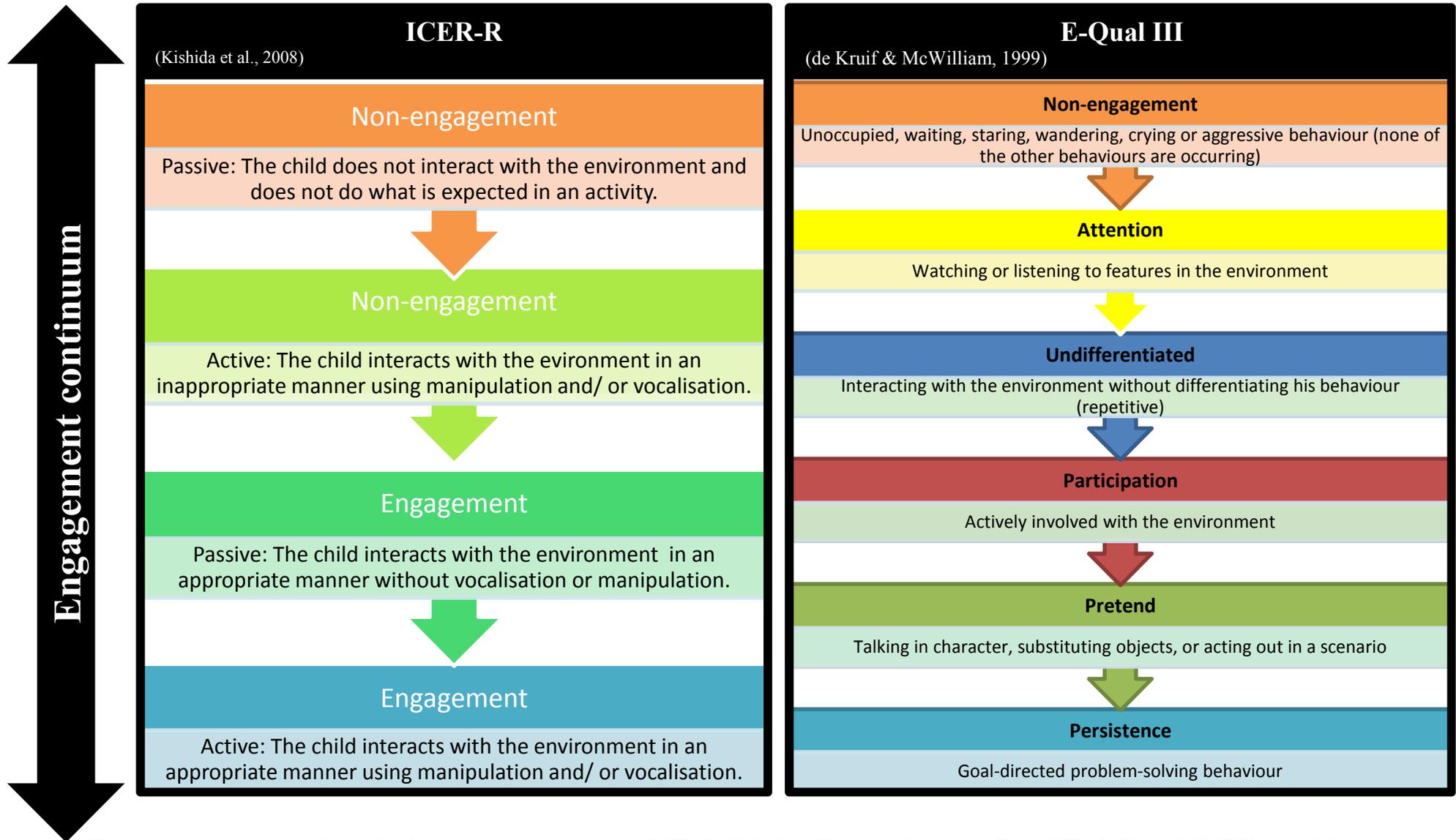


Figure 4.3: Comparison of the levels of engagement assessed in the ICER-R (Kishida & Kemp, 2009) and the E-Qual III (de Kruif & McWilliam, 1999)

As depicted in Figure 4.3, the ICER-R (Kishida & Kemp, 2009) and the E-Qual III (de Kruif & McWilliam, 1999) both measure engagement on a continuum. The ICER-R (Kishida & Kemp, 2009) has four levels of engagement on the continuum. Passive non-engagement constitutes the lowest level, followed by active non-engagement, passive engagement, and active engagement as the highest level. The E-Qual III (de Kruif & McWilliam, 1999), in contrast, has six levels on the continuum. The lowest level is non-engagement. This is followed by the first engagement level of attention, then undifferentiated engagement, participation as the third engagement level, pretend, and, the highest engagement level, persistence. It is clear from the illustration that the ICER-R (Kishida & Kemp, 2009) has more levels of non-engagement than the E-Qual III (de Kruif & McWilliam, 1999), but fewer levels of engagement.

Positive correlations were reported for total engaged behaviours between the ICER-R (Kishida & Kemp, 2009) and the E-Qual III (de Kruif & McWilliam, 1999; Kishida, Kemp, & Carter, 2008). However, only the ICER-R (Kishida & Kemp, 2009) was applied with children with a range of severe disabilities (Kemp, Kishida, Carter, & Sweller, 2013; Kishida et al., 2008; Kishida & Kemp, 2006). Furthermore, the highest two levels of engagement in the E-Qual III (de Kruif & McWilliam, 1995) require the use of language to be scored. For the purpose of this study, where the participants were severely motor-impaired young children, the use of language was unlikely. Due to the commonly co-occurring communication deficits in this group (Imms, 2008a), the full range of engagement levels could not be used. Of the two measures, the ICER-R (Kishida & Kemp, 2009) has been reported to have a reduced training time for raters (Kishida, Kemp, & Carter, 2008) when compared to the E-Qual III (de Kruif & McWilliam, 1995). The E-Qual III also requires a specialised computing system for the scoring of data. Based on these characteristics, the ICER-R (Kishida & Kemp, 2009) was selected as the measure of the dependent

variable, engagement. The dependent variable in this study was probed during baseline, intervention and post-intervention phases.

#### **4.4. Translation of study materials**

The demography of South Africa necessitated the inclusion of participants with home languages other than English in this study. As isiZulu is the predominant language spoken in KwaZulu-Natal (Statistics South Africa, 2012), it was chosen as the language for intervention. Fortunately the researcher had studied isiZulu at university level and she had five years of experience working with young children in isiZulu, hence she was competent to implement the programme in isiZulu. However as she did not regularly make use of written isiZulu, nor did she have intimate knowledge of the community in which the study was conducted, additional translators were required to ensure that the translation process was sufficient.

The materials translated included the information letters (Appendix G); consent forms (Appendix I); the biographical questionnaire (Appendix F); the GMFCS family report questionnaire (Dietrich et al., 2007) (Appendix A); and scripts for the non-powered mobility programme (Appendix C and Appendix D). The translations were done individually using the procedures outlined below.

##### **4.4.1 Translators**

Translators should not merely be competent in translation. They should also have insight into the culture associated with the language into which they are translating and the subject matter (Hambleton & Kanjee, 1993). The following criteria were therefore identified as important in the selection of translators:

The first criterion important for the translators involved in the current study was an ability to understand the target audience for the content. As this study focused on young children with severe motor impairments, an ability to understand young children, as well as their parents was required.

The second criterion for the translators was the ability to understand the context of the input. For this study, the context was a therapeutic setting. Hence an understanding of teaching and learning was required.

The final criterion for the translators involved an ability to make use of both written and spoken isiZulu. Although the context of the study was a therapeutic setting with young children, the translation also included documents for the caregivers of the children which were translated.

Based on these criteria, the following translators were selected:

- i. Translator 1 was a bilingual English/ isiZulu speaker who was trained as an occupational therapist and worked with children with severe impairments. Translator 1 had experience as a translator in other research studies. Translator 1 was fluent in both written and spoken English and isiZulu.
- ii. Translator 2 was a bilingual English/ isiZulu speaker who was trained as a teacher and had extensive experience (40 years) in teaching isiZulu. She was a marker of isiZulu matric exams and had produced numerous Zulu textbooks. Translator 2 was fluent in both written and spoken English and isiZulu.
- iii. Translator 3 was a bilingual isiZulu/ English speaker. She was a member of the community in which the study was conducted and a parent of a child with impairments.

After completing high school, she worked in the paramedical field (as a physiotherapy assistant). Translator 3 was fluent in both written and spoken English and isiZulu.

#### 4.4.2 Translation process

The translation of materials is conducted not only for the sake of linguistic equivalence (words exactly the same), but also for functional equivalence (produces the same target behaviour) and cultural equivalence (same interpretation) (Bornman, Sevcik, Ronski, & Pae, 2010; Peña, 2007). In order to ensure a valid translation, a structured process was followed as illustrated in Figure 4.4.

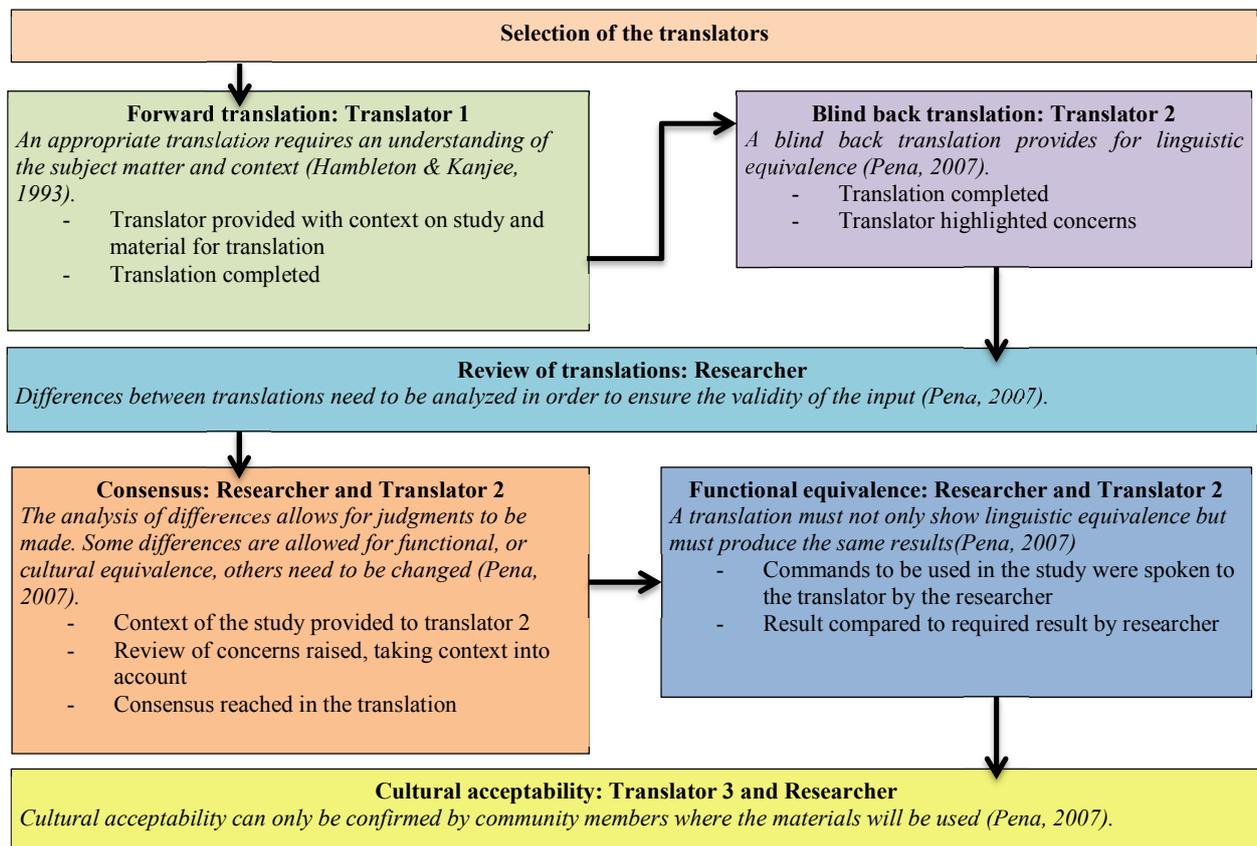


Figure 4.4: Procedures followed in the translation of materials (based on Peña, 2007)

Figure 4.4 illustrates the procedures used in the translation of materials for this study. The process began with a forward translation by Translator 1, who had background knowledge of the

study. This was followed by a blind back translation of the materials by Translator 2 to determine linguistic equivalence (Peña, 2007). Translator 2 also highlighted areas of concern. The researcher then analysed the forward and back translations for differences before meeting with the second translator. On meeting with Translator 2 the context of the study was provided and the concerns she had raised were considered. With the context in place, the concerns were resolved and the final translation was confirmed (Peña, 2007). Translator 2 and the researcher then considered the functional equivalence of the commands in particular, with the translator following all instructions exactly as provided by the researcher. The responses were compared to those required for the study. Finally all translations were provided to Translator 3 who had community knowledge to obtain her input regarding the cultural acceptability of the translations and the input (Hambleton & Kanjee, 1993). Translator 3 indicated that she was comfortable with the translations provided and felt them to be appropriate to the therapy setting.

#### **4.4.3 Translator training**

Translator 1 assisted not only with the translation of materials for the study, but also in the provision of information to caregivers and in the collection of pre-assessment information. In order to prepare for this, the translation of the materials was completed first of all. When the final version of the translations was ready, it was returned to Translator 1 to prepare for the information session with the caregivers. Prior to the information session, the researcher met with Translator 1 and explained the aims of the study, and the specific aims of the information morning. The aims of the information morning included providing information to the caregivers of potential participants that would allow them to decide on their child's participation in the study and answer any questions that they raised about the study. Those caregivers who gave consent for their children to

be involved in the study had to complete the consent form and agree to the pre-assessment measures.

Throughout the information morning, the researcher presented the information in English, after which Translator 1 translated this information into isiZulu, as well as any questions from the caregivers into English.

#### **4.5. Conclusion**

In this chapter, sub-aim (i) of the study was addressed and the steps followed in the development of the non-powered mobility programme were described. Next, sub-aim (ii) was addressed in the identification of the ICER-R (Kishida & Kemp, 2009) as the tool to be used in the measurement of engagement in this study. The chapter concluded with a description of the procedures followed in the translation of documents and scripts for the study into isiZulu, as required for sub-aim (iii) of the study.

## CHAPTER 5: RESULTS

### 5.1 Introduction

In this section the response of the participants to the non-powered mobility programme is discussed. This is followed by the discussion of the effect of non-powered, self-initiated mobility on the participants' engagement. The section begins with the definition of the terms used. The response of the participants is presented first. This is followed by results for total engagement (active engagement + passive engagement), and total non-engagement (active non-engagement + passive non-engagement). The engagement and non-engagement data is presented graphically and followed by visual analysis of the results, including analysis of level, trend relative change, and trend variability, for each participant across each phase. Statistical analysis of the results, which includes the calculation of the NAP with confidence intervals, follows before an analysis of the results across participants for effect.

### 5.2 Terms

For the visual analysis, specific terms are referred to. The definitions and descriptions of these terms are provided below as applied to this study.

*Level:* The level of a phase is the median of all the data points within that phase (Horner, Swaminathan, Sugai, & Smolkowski, 2012).

*Trend relative change:* The trend is the slope of the data within a specific phase (Horner et al., 2012). The trend of a phase can be drawn by calculating the mean for the first half of the phase, and then for the second half of the phase. The line between the two means is the trend. The size of the trend can be calculated through the use of relative change (Relative change = Mean 2 – Mean 1) (Horner et al., 2012). In the current study, three possible trends are described:

- An improving trend – one in which engagement is increasing – is indicated by a positive relative change (RC) value.
- A deteriorating trend – one in which engagement is decreasing – is indicated by a negative relative change (RC) value.
- A steady trend – one in which there is little or no slope (for the purpose of this study a trend with RC of between +/-3 (<10%) change was determined to be steady).

*Trend stability or variability:* Stability and variability are terms that describe the deviation of scores around the trend. The introduction of the independent variable can cause changes in the stability of the trend from one phase to the next. (Gast & Spriggs, 2010; Horner et al., 2012). In order to determine the presence of stability, a stability envelope is typically drawn on either side of the trend. For this study, a stability envelope of +/-3 (10%) from the trend was used. Although typically a stability envelope of 20% from the trend is used, this is only applicable when the data is presented as a percentage. When, as for this study, data is not a percentage it is recommended that the specific level of stability be defined by the researcher (Gast & Spriggs, 2010). For this a stability envelope of 10% was selected. For a trend that is described as stable, 80% of the data points fall within the stability envelope. In contrast, a variable trend has more than 20% of the data falling outside the stability envelope.

### **5.3 Determination of change**

Within a multiple probe design across participants, a change in level, trend or variability (as a result of the independent variable) for an individual participant must be replicated with at least two other participants for an effect to be indicated (Horner et al., 2012). For a change to be indicated between the baseline and the intervention phases, the change needs to be sufficient such that it could not have occurred by chance. Changes are measured in level, immediacy, trend

relative change and trend variability. For the current study, the following criterion have been set to indicate that sufficient change has occurred and that the introduction of the independent variable has resulted in a change in the dependent variable (Gast & Spriggs, 2010).

- *Level*: A change in level greater than 6 points (10%) between medians of phases provides evidence of a change in level.
- *Immediacy*: The difference between the mean of the final three data points in one phase and the mean of the first three data points in the next phase is termed immediacy. This provides an indication of how quickly a change occurred following the introduction of the independent variable. An immediacy of greater than 6 (10%) provides evidence of change between phases.
- *Trend relative change*: A change in the relative change of a trend of greater than 6 points between phases.
- *Trend variability*: A change in variability, greater than 25%, between phases.

#### **5.4 Response of participants 1-4 to the non-powered mobility programme**

The response of participants 1-4 to the non-powered mobility programme is described below. Each participant is described based on a the level of mobility they achieved in comparison to the other participants, their manner of propulsion, the ongoing facilitation which was still required and their feelings regarding the non-powered, self-initiated mobility device. For participant 3, the impact of her associated condition (epilepsy) on the programme is also discussed.

##### **5.4.1 Participant 1**

Participant 1 achieved the greatest of mobility of all the participants. He made use of both his arms and legs, in a reciprocal pattern, to propel himself. During the final session of the intervention phase participant 1 was able to independently move across the intervention area

(approximately 3m) slowly. His movements were mostly successful, but the positioning of his feet to the floor became problematic on a regular basis, as he pushed parallel to the floor rather than downwards into it. With these movements he was unable to move the non-powered, self-initiated mobility device. Using repeated attempts he would regain the correct foot positioning and continue his movement. Participant 1 loved his non-powered, self-initiated mobility device. He would point to it as soon as he came in the door and grumbled at the end of each session as he was taken off.

#### **5.4.2 Participant 2**

Participant 2 also achieved a functional level of mobility. He primarily made use of his legs for propulsion, although did attempt to assist with his hands at times. His leg movements included both bilateral extension and flexion and a reciprocal pattern at times. Participant 2 was able to move independently across approximately half the intervention area, however his movements included many unsuccessful attempts (at least half). These were often as a result of incorrect target body part placement due to a lack of refinement in the placement movement. This resulted in participant 2 kicking the air instead of the floor or sliding his foot along the floor rather than pushing off it. Participant 2 was very excited about using his non-powered, self-initiated mobility and often repeated a number of movements in rapid succession with limited control and success in an attempt to move quickly.

#### **5.4.3 Participant 3**

Participant 3 achieved the lowest mobility of the participants. Due to her difficulty in tolerating a prone position she was in side-lying on the non-powered, self-initiated mobility device. From this position she made use of her right leg for mobility. This consisted of extension and flexion of the leg, pushing against the floor. At times when the isolation of the limb was difficult she would use a full body extension pattern to achieve leg extension. Participant 3 moved

herself approximately 3 times during each session (less than 1m of movement). She required much prompting, and following the use of full body extension required the facilitation of foot placement before she was able to move again. Participant 3 appeared to enjoy using her non-powered, mobility device, even though this was difficult for her, she smiled in delight each time a movement was successful. In addition to the challenges presented by her physical impairments, participant 3 also suffered from epileptic seizures during two intervention sessions. The first seizure occurred towards the end of session 22 (after the period during which engagement was measured), this however was a severe seizure following which she cried and could not be consoled. The session was concluded early due to this. She then suffered another seizure during session 23 (during the period in which engagement was measured). Following this seizure however she remained calm and smiled when asked if she would like to continue. With the consent of her caregiver the session was completed.

#### **5.4.4 Participant 4**

Participant 4 achieved occasional independent mobility. He made use of his legs for propulsion, and primarily his right leg. His limited range of movement in hips, knees and ankles resulted in him having difficulty positioning his feet for pushing, and he had a strong extension pattern which often inhibited his ability to flex his leg after extension. Participant 4 was able to move approximately half a metre independently during a session, but required assistance to break the extension pattern in his legs (most times) before he was able to initiate another movement himself. Participant 4 enjoyed using his non-powered, self-initiated mobility device. He became very excited about specific movements – particularly knocking down the skittles, even though this made movement more difficult for him, as his tone increased the more excited he became.

#### **5.4.5 Summary**

In summary all participants initiated mobility independently by the end of the non-powered mobility programme. Participants 1 and 2 were able to initiate and complete movements, although ongoing facilitation was still required at times. Participants 3 and 4 initiated movements but required facilitation for the completion of these in order for them to result in mobility.

### 5.5 Effect of non-powered, self-initiated mobility on engagement and non-engagement

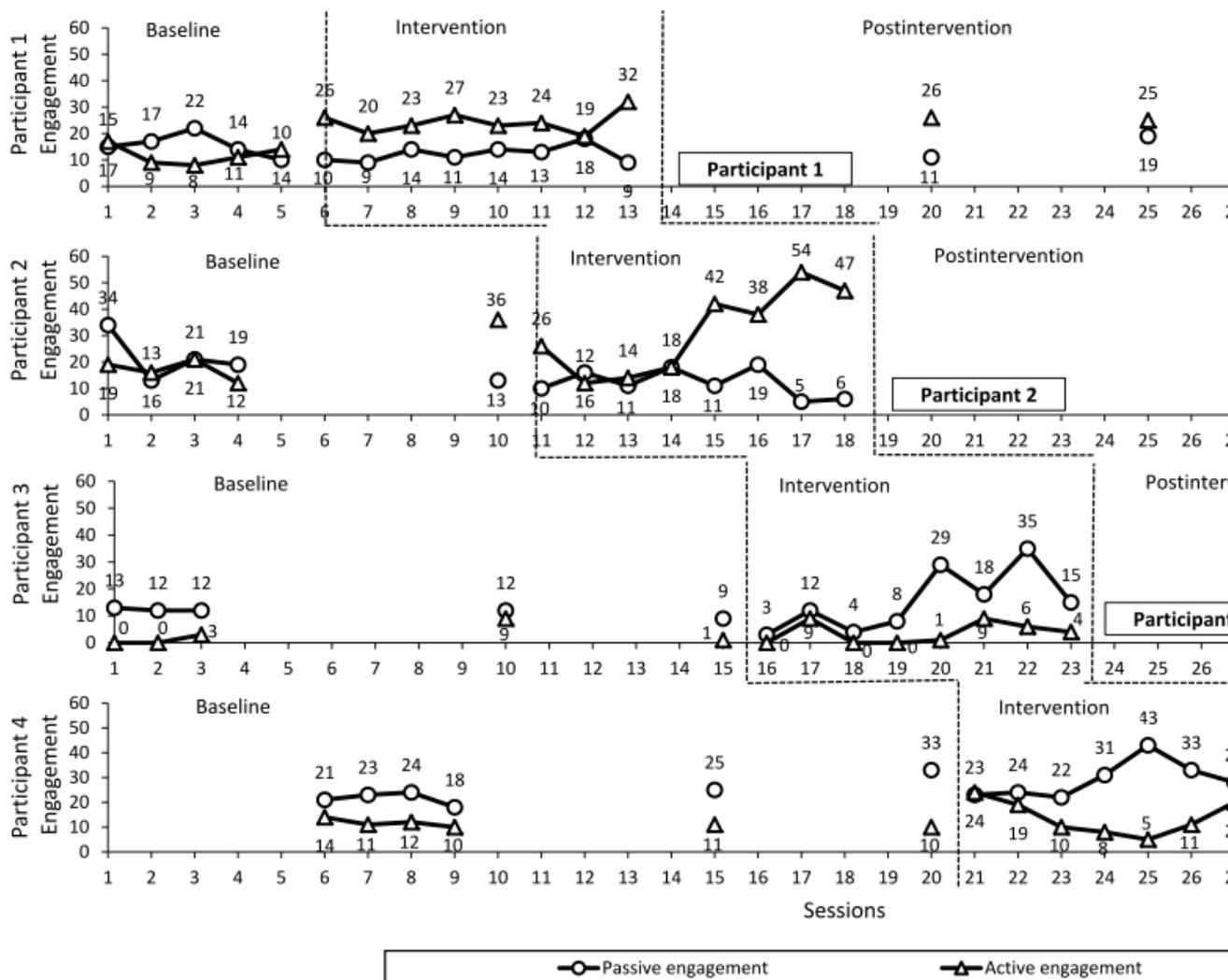


Figure 5.1 represents the performance of participants 1 to 4 as scored using the ICER-R (Kishida & Kemp, 2006) in the baseline, intervention and post-intervention phases. Engagement (active engagement + passive engagement) and non-engagement (active non-engagement + passive non-

engagement) are represented. Visual analysis of the results is presented including analysis of level, trend relative change and trend variability. Results are discussed across participants for each phase of the study. Statistical analysis of the results is done before an analysis of the results is made across participants for effect. The results are then discussed.

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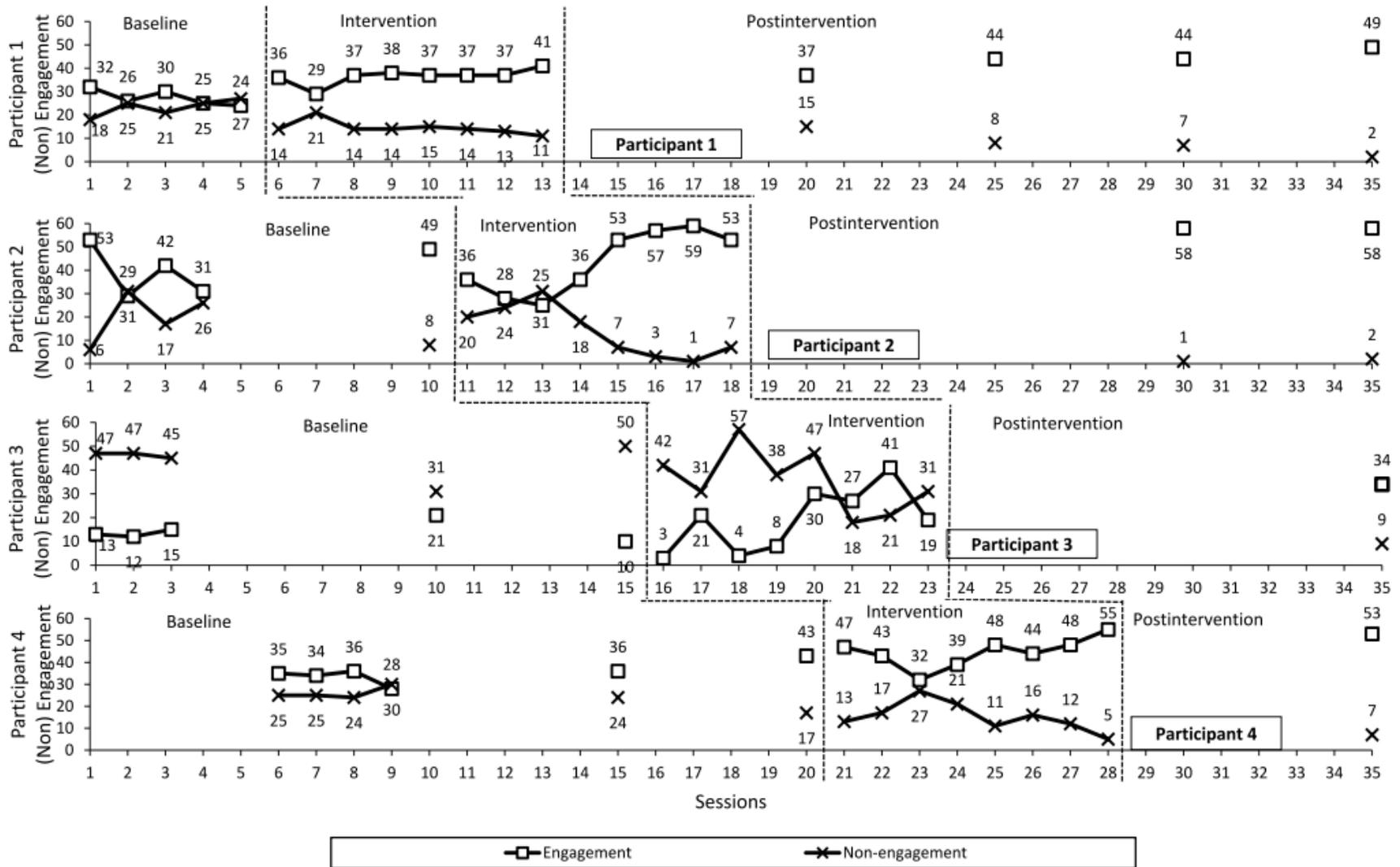


Figure 5.1: Engagement and non-engagement of participants 1 to 4 across all phases of the study

### **5.5.1 Visual analysis of engagement and non-engagement in the baseline phase**

#### **5.5.1.1 Participant 1**

In the baseline phase for engagement, participant 1 began with a score of 32 in Session 1. This deteriorated to 26 for Session 2 and improved to 30 for Session 3. The score reverted to 25 in Session 4 and remained steady at 24 for Session 5. Engagement for Participant 1 showed a median level of 26 with a deteriorating (RC -4.5) and stable trend.

In the baseline phase for non-engagement, Participant 1 began with a score of 18, which improved to 25 in Session 2 but deteriorated to 21 in Session 3. Further improvements were seen in Sessions 4 (25) and 5 (27). Non-engagement for Participant 1 showed a median level of 25 with an improving (RC +4.5) and stable trend.

#### **5.5.1.2 Participant 2**

In the baseline phase for engagement, Participant 2 began with a score of 53 in Session 1. This was followed by a decline in Session 2 to 29, and an improvement to 42 in Session 3. Another deterioration was evident in Session 4 (31), followed by an improvement to 49 in Session 10. Engagement for Participant 2 showed a median level of 42 with a steady (RC -1) but variable (80%) trend.

In the baseline phase for non-engagement, Participant 2 began with a score of 6 in Session 1. This was followed by an improvement to 31 in Session 2 but deterioration to 17 in Session 3. Another improvement to 26 followed in Session 4 and deterioration to 8 in Session 10. Non-engagement for Participant 2 showed a median level of 17 with a steady (RC -1.5) but variable (80%) trend.

### ***5.5.1.3 Participant 3***

In the baseline phase for engagement, Participant 3 began with a score of 13 in Session 1 and remained steady in Sessions 2 (12) and 3 (15). An improvement to 21 was evident in Session 10 but this reverted to 10 for Session 15. Engagement for Participant 3 showed a median level of 13 with a steady (RC +3) and stable trend.

In the baseline phase for non-engagement, Participant 3 began with a score of 47 in Session 1. This remained steady for Sessions 2 (47) and 3 (45). A decline was seen in Session 10 (31) and an improvement in Session 15 (50). Non-engagement for Participant 3 showed a median level of 47 with a deteriorating (RC -6.5) but variable (40%) trend.

### ***5.5.1.4 Participant 4***

Participant 4 only joined the baseline phase of intervention in Session 6, as he was ill during sessions 1 to 5. In the baseline phase for engagement, his scores began at 35 for Session 6 and remained steady for Sessions 7 (34) and 8 (36). A decline to 28 was evident in Session 9 but this reverted to 36 for Session 15 before improving to 33 in Session 20. Engagement for Participant 4 showed a median level of 35.5 with a steady (RC +0.6) and stable trend.

In the baseline phase for Participant 4, non-engagement scores began at 25 in Session 6 and remained steady for Sessions 7 (25), and 8 (25). An improvement to 30 was evident in Session 9 but this reverted to 24 in Session 15. A decline to 17 was seen in Session 20. Non-engagement for Participant 4 showed a median level of 24.5 with a steady (RC -0.93) and stable trend.

### ***5.5.1.5 Summary***

Engagement in the baseline phase provided evidence of stable baselines for Participants 1, 3 and 4. Participant 1 had a deteriorating trend (RC -4.5) but the scores for this were stable

compared to the trend. Participant 2 had a steady trend (RC -1) but variable scores (80%), while Participants 3 and 4 had steady trends with RC of +3 and +0.6 respectively and stable scores.

Non-engagement in the baseline phase provided evidence of stable baselines for Participants 1 and 4. Participant 1 had an improving trend (RC +4.5) in the baseline phase but the scores for this were stable compared to the trend. Participant 2 had a steady trend (RC -1.5) but variable scores (80%). Participant 3 had a deteriorating trend (RC -6.5) but variable scores (40%) and Participant 4 had a steady trend (RC -0.93) and stable scores.

## **5.5.2 Visual analysis of engagement and non-engagement in the intervention phase**

### **5.5.2.1 Participant 1**

Engagement in the intervention phase for Participant 1 began with a score of 36 in Session 6. This was higher than the highest score in the baseline phase. A decline to 29 was seen in Session 7 but this reverted to 37 for Session 8 and remained steady in Sessions 9 (38); 10 (37); 11 (37) and 12 (37). An improvement to 41 was then seen in Session 13. Engagement for Participant 1 showed a median level of 37 with a steady (RC +1) and stable trend.

Non-engagement in the intervention phase for Participant 1 began with a score of 14 in Session 6. This was lower than the lowest score in the baseline phase. An improvement to 21 was evident for Session 7 but this reverted to 14 for Session 8 and remained steady in Sessions 9 (14), 10 (15), 11 (14), 12 (13) and 13 (11). Non-engagement for Participant 1 showed a median level of 14 with a steady (RC -2.5) and stable trend.

### **5.5.2.2 Participant 2**

Engagement in the intervention phase for Participant 2 started with a score of 36 in Session 11. This was lower than the score for the last session in the baseline phase. A decline was evident in Sessions 12 (28) and 13 (25). This was followed by improvements in Sessions 14 (36), 15 (53), 16 (57) and 17 (59), and deterioration to 53 in Session 18. Engagement for Participant 2 showed a median level of 44.5 with an improving (RC +23) but variable (25%) trend.

Non-engagement in the intervention phase for Participant 2 started with a score of 20 in Session 11. This was higher than the score for the last session in the baseline phase. Improvements were evident in Sessions 12 (24) and 13 (31). This was followed by deterioration in Sessions 14 (18), 15 (7), 16 (3) and 17 (1) and an improvement to 7 in Session 18. Non-engagement for Participant 2 showed a median level of 12.5 with a deteriorating (RC -18.75) but variable (37,5%) trend.

### **5.5.2.3 Participant 3**

Engagement in the intervention phase for Participant 3 began with a score of 3 in Session 16. This was lower than the score for the last session in the baseline phase. An improvement to 21 was evident in Session 17, which reverted for Sessions 18 (4) and 19 (8). This was followed by an improvement to 30 for Session 20, a steady score of 27 for Session 21 and a further improvement to 41 in Session 22. A decline to 19 was evident in Session 23. Engagement for Participant 3 showed a median level of 20 with an improving (RC +14) but variable (50%) trend.

Non-engagement in the intervention phase for Participant 3 began with a score of 42 in Session 16. This was lower than the score for the last session in the baseline phase. A decline to 31 was evident to Session 17 but this was followed by an improvement to 57 in Session 18. Further deterioration and improvement were evident in Sessions 19 (38) and 20 (47). A decline to 18 was

then seen in Session 21, followed by improvements in Sessions 22 (21) and 23 (31). Non engagement for Participant 3 showed a median level of 34.5 with a deteriorating (RC -15.75) but variable (62,5%) trend.

#### ***5.5.2.4 Participant 4***

Engagement in the intervention phase for Participant 4 began with a score of 47 in Session 21. This was higher than the score for the last session in the baseline phase. A decline was evident for Sessions 22 (43) and 23 (32), followed by improvements in Sessions 24 (39) and 25 (48). Session 26 remained steady at 44 and further improvements were evident in Session 27 (48) and Session 28 (55). Engagement for Participant 4 showed a median level of 45.5 with an improving (RC +7) but variable (25%) trend.

Non-engagement in the intervention phase for Participant 4 began with a score of 13 in Session 21. This was lower than the score for the last session in the baseline phase. It was followed by improvement in Sessions 22 (17) and 23 (27) and deterioration in Sessions 24 (21) and 25 (11). An improvement to 16 was evident in Session 26 but was followed by deterioration in Sessions 27 (12) and 28 (5). Non-engagement for Participant 4 showed a median level of 14.5 with a deteriorating (RC -8.5) but variable (25%) trend.

#### ***5.5.2.5 Summary***

In the intervention phase for engagement, Participant 1 showed a change in level between the baseline and the intervention phases (+11) that was immediate (7.7), as well as a steady (RC +1) and stable trend. Participant 2 showed an immediate (-11) change in level between the baseline and the intervention phases (+2.2), as well as an improving (RC +23) but variable (25%) trend. Participant 3 showed a change in level between the baseline and the intervention phases that was immediate (-6), and she also showed an improving (RC +14) but variable (50%) trend. Participant

4 showed a change in level between the baseline and the intervention phases but this was not immediate (5). He showed an improving (RC +7) but variable (25%) trend.

In the intervention phase for non-engagement, Participant 1 showed a change in level between the baseline and the intervention phases (-11) which was immediate (-7.96), as well as a steady (RC -2.5) and stable trend. Participant 2 also showed change in level between the baseline and the intervention phases (-4.5) which was immediate (8), but a deteriorating (RC -18.75) and variable (37.5) trend. For Participant 3 a change in level occurred from the baseline to the intervention phase (+3.5), which was not shown to be immediate (1.3). She furthermore showed a deteriorating (RC -15.75) and varied trend. Participant 4 had no change in level between the baseline and the intervention phases (+0.5) for non-engagement. He did however show a deteriorating (RC -8.5) and variable (25%) trend in the intervention phase.

### 5.5.3 Statistical analysis of engagement and non-engagement

As indicated and discussed in Section 3.10, statistical analysis of the results for engagement and non-engagement supports visual analysis and provides improved objectivity, precision, and certainty to visual analysis. For this study, the percentage of non-overlap of all pairs was used (NAP), as it compares each data point in the baseline phase with each data point in the intervention phase for overlap (See Section 3.10). A confidence interval (CI) of 85% was used.

Table 5.1 Statistical analysis of engagement and non-engagement

Variable	Test	Participant 1	Participant 2	Participant 3	Participant 4
Engagement	NAP	0.950***	0.575*	0.588*	0.865**
	CI at 85%	(0.747; 0.991)	(0.282; 0.770)	(0.276; 0.787)	(0.595; 0.959)
Non-engagement	NAP	0.963***	0.613*	0.725**	0.865**
	CI at 85%	(0.800; 0.993)	(0.302; 0.805)	(0.423; 0.881)	(0.595; 0.959)

\*NAP effect 0-0.65 weak \*\*NAP effect 0.66-0.92 medium \*\*\*NAP effect 0.93-1.00 large (Parker & Vannest, 2009)

Table 5.1 above indicates the result of the statistical analysis for engagement and non-engagement. A large effect is evident for both engagement (0.950) and non-engagement (0.963)

for participant 1 with CI's of (0.747; 0.991) and (0.800; 0.993) respectively. Participant 2 showed evidence of a weak effect for both engagement (0.575) and non-engagement (0.613) with wide CI's of (0.282; 0.770) and (0.302; 0.805) respectively. Participant 3 showed evidence of a weak effect for engagement (0.588) but a medium effect on non-engagement (0.725) with CI's of (0.276; 0.787) and (0.423; 0.881) respectively. Participant 4 showed evidence of medium effects for both engagement (0.865) and non-engagement (0.865) with CI's of (0.595; 0.959) for both.

#### **5.5.4 Analysis of engagement and non-engagement results for effect**

As explained in Section 5.3 in respect of a multiple probe design across participants, a change in level, trend or variability as a result of the independent variable for an individual participant must be replicated with at least two other participants to indicate an effect (Horner et al., 2012). A summary of the results for Participants 1 to 4 is provided in Table 5.2.

Table 5.2: Summary of engagement and non-engagement data across Participants 1 to 4

		Participant 1		Participant 2		Participant 3		Participant 4		Therapeutic Effect	
		Baseline	Intervention	Baseline	Intervention	Baseline	Intervention	Baseline	Intervention		
Engagement	Stable baseline		✓		✗		✓		✓	✓	
	Change in level	26	37	42	44.5	13	20	35.5	45.5	✓	
	Change in trend	-4.5	+1	-1	+23	+3	+14	+0.6	+7	✓	
	Change in variability (%)	20	12.5	80	25	20	50	16.7	25	✗	
	Immediacy		7.7		-11		-6		5		✗
	NAP (CI at 85%)		0.950***(0.747; 0.991)		0.575*(0.282; 0.770)		0.588*(0.276; 0.787)		0.865**(0.595; 0.959)		✗
Non-Engagement	Stable baseline		✓		✗		✗		✓	✗	
	Change in level	25	14	17	12.5	47	34.5	24.5	14.5	✓	
	Change in trend	4.5	-2.5	-1.5	-18.75	-6.5	-15.75	-0.93	-8.5	✓	
	Change in variability (%)	20	16.7	80	37.5	40	62.5	16.7	25	✗	
	Immediacy		-7.96		8		-6.5		-5		✓
	NAP (CI at 85%)		0.963***(0.800; 0.993)		0.613*(0.302; 0.805)		0.725**(0.423; 0.881)		0.865**(0.595; 0.959)		✓

\*NAP effect 0-0.65 weak \*\*NAP effect 0.66-0.92 medium \*\*\*NAP effect 0.93-1.00 large (Parker & Vannest, 2009)

Table 5.2 provides a summary of data which illustrates the effect of non-powered, self-initiated mobility on both engagement and non-engagement.

For engagement, a stable baseline was evident for Participants 1, 3 and 4. This was followed by an effect of change in level for all participants. The change in level indicated improved engagement of 11, 2.5, 7 and 10 from the baseline to the intervention phases for Participants 1 to 4 respectively. In addition to an effect on the change of level, an effect of change in trend (RC) became evident for Participants 2, 3 and 4. This change in trend was an improvement of +22, +11 and +6.4 respectively.

For non-engagement, a stable baseline was evident for Participants 1 and 4. This was followed by an effect of change in level amounting to -11, -4.5, -12.5 and -10 for Participants 1 to 4 respectively, which indicated a decline from the baseline to the intervention phases. The effect of change in level was immediate for Participants 1 (-7.96), 2 (8) and 3 (-6.5). In addition to an effect of change in level, an effect of change in trend (RC) is evident for all participants. The change in trend deteriorated by -6.5, -17.25, 9.25 and -9.43 for Participants 1, 2, 3 and 4 respectively. The statistical analysis of results for participants 1, 3 and 4 indicated a medium NAP effect for participants 3 (0.725) and 4 (0.865) and a large effect for participant 1 (0.963).

The results that were obtained provide evidence of an effect on both engagement and non-engagement due to the introduction of non-powered, self-initiated mobility. The nature of these results reveals that more time was spent interacting appropriately in play and less time spent in non-engagement as the non-powered, self-initiate mobility programme was introduced. The improvement and deterioration in engagement and non-engagement respectively were immediate on introduction of the non-powered mobility programme but notably also progressive, in that

improving and deteriorating trends for engagement and non-engagement respectively were evident throughout the programme.

### 5.6 Effect of non-powered, self-initiated mobility on active engagement and passive engagement

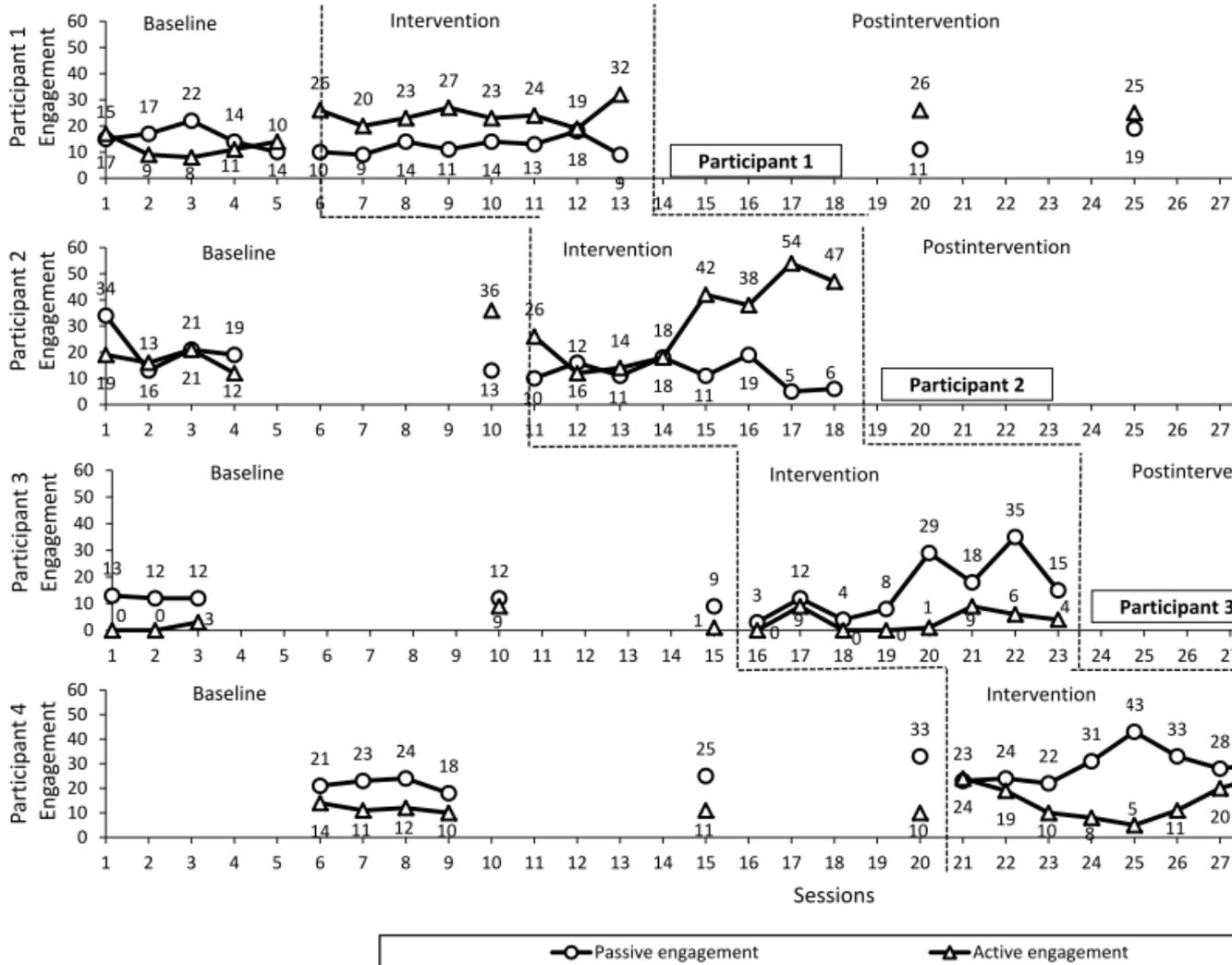


Figure 5.2 represents the performance of Participants 1 to 4 as scored with the ICER-R (Kishida & Kemp, 2006) in the baseline, intervention and post-intervention phases. Both active and passive engagement levels are represented for each of the four participants. Visual analysis of the results is presented, including analysis of level, trend relative change and trend variability, and the results

are discussed across participants for each phase of the study. The statistical analysis of the results for active and passive engagement follows next, after which the results across participants are analysed for effect and then discussed.

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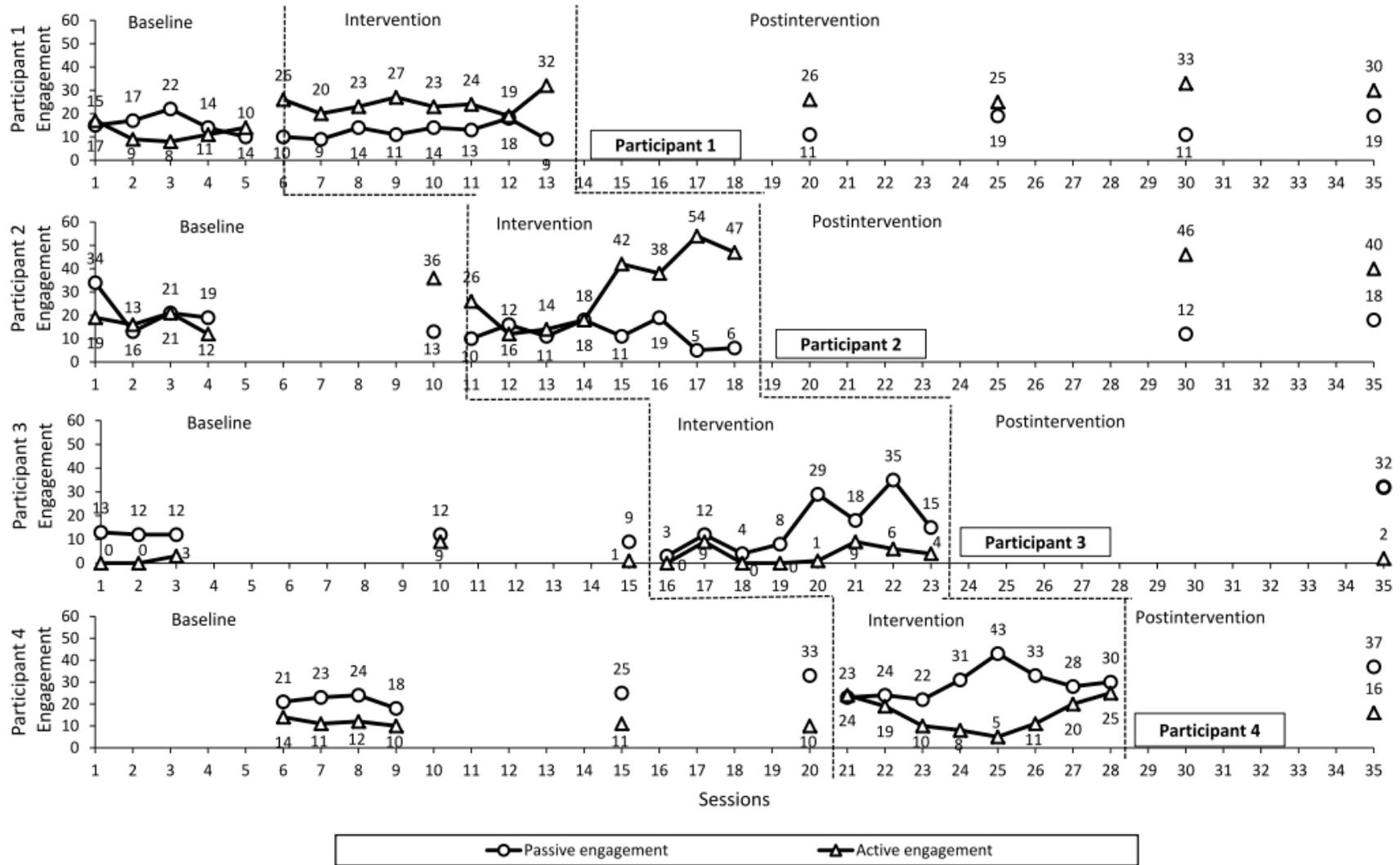


Figure 5.2: Active and passive engagement of Participants 1 to 4 across all phases of the study

## **5.6.1 Visual analysis of active and passive engagement in the baseline phase**

### **5.6.1.1 Participant 1**

In Figure 5.2, active engagement scores in the baseline phase for Participant 1 began with a score of 17 during Session 1. This was followed by a deterioration to 9 for Session 2, remained steady for Sessions 3 (8); and 4 (11), and again improved to 14 in Session 5. Active engagement for Participant 1 showed a median level of 11 with a steady (RC -0.5) and stable trend.

Passive engagement scores for Participant 1 began at 15 in Session 1 and remained steady for Session 2 (17). An improvement to 22 was evident in Session 3 but this reverted to 14 for Session 4 and deteriorated further to 10 in Session 5. Passive engagement for Participant 1 showed a median level of 15 with a deteriorating (RC -4) and stable trend.

### **5.6.1.2 Participant 2**

Active engagement scores in the baseline phase for Participant 2 began at 19 for Session 1 and remained steady for Sessions 2 (16) and 3 (21). These were followed by a decline to 12 in Session 4 and an improvement to 36 in Session 10. Active engagement for Participant 2 showed a median level of 19 with an improving (RC +6) but variable (40%) trend.

Passive engagement scores in the baseline phase for Participant 2 began at 34 for Session 1. This was followed by deterioration to 13 in Session 2, and an improvement to 21 in Session 3. The scores remained steady in Session 4 (19) but deteriorated to 13 in Session 10. Passive engagement for Participant 2 showed a median level of 21 with a deteriorating (RC -7.5) but variable (40%) trend.

### **5.6.1.3 Participant 3**

Active engagement scores for Participant 3 began with a score of 0 and remained steady through Sessions 2 (0) and 3 (3). An improvement to 9 was evident in Session 10 but this reverted to 1 for Session 15. Active engagement for Participant 3 showed a median level of 1 with an improving (RC +5) and stable trend.

Passive engagement scores for Participant 3 began with a score of 13 in Session 1 and remained steady in sessions 2 (12); 3 (12); 10 (12) and 15 (9). Passive engagement for Participant 3 showed a median level of 12 with a steady (RC -2) and stable trend.

### **5.6.1.4 Participant 4**

Active engagement scores for Participant 4 began at 14 in Session 6, and remained steady through Sessions 7 (11); 8 (12); 9 (10); 15 (11) and 20 (10). Participant 4 showed a median of 11 with a steady (RC -2) and stable trend.

Passive engagement scores for Participant 4 began at 21 for Session 6 and remained steady for Sessions 7 (23) and 8 (24). A decline to 18 occurred in Session 9 but this reverted to 25 for Session 15 and improved to 33 in Session 20. Passive engagement for Participant 4 showed a median of 23.5 with a steady (RC +2.66) and stable trend.

### **5.6.1.5 Summary**

Active engagement in the baseline phase provided evidence of stable baselines for Participants 1, 3 and 4. Participants 1 and 4 had steady trends with stable scores of 11 for both, while Participant 2 had an improving trend (RC +6.5) but variable (40%) scores. Participant 3 showed an improving trend (RC +5) with stable scores.

Passive engagement in the baseline phase provided evidence of stable baselines for Participants 1, 3 and 4. Both Participants 1 and 2 showed a deteriorating trend with slopes of -4 and -7.5 respectively in the baseline phase, but Participant 1's scores were stable while those of Participant 2 were variable (40%). Participants 3 and 4 both showed steady trends with stable scores of 15 and 23.5 respectively.

## **5.6.2 Visual analysis of active and passive engagement in the intervention phase**

### **5.6.2.1 Participant 1**

Active engagement scores for Participant 1 began at 26 in Session 6. This was higher than the highest score in the baseline phase. A deterioration to 20 was evident in Session 7 but improvements were then seen in Sessions 8 (23) and 9 (27). A deterioration followed in Sessions 10 (23), 11 (24) and 12 (-5), but this changed with an improvement to 32 in Session 13. Active engagement for Participant 1 showed a median level of 23.5 with a steady (RC +0.5) and stable trend.

Passive engagement scores for Participant 1 in the intervention phase began at the same score as the final session in the baseline phase (10) and remained steady for Session 7(9). A peak (14) was evident in Session 8, which reverted to 11 for Session 9 but was repeated (14) in Session 10. The results remained stable (13) for Session 11 and another peak (18) was evident for Session 12, which was followed by a dip (9) in Session 13. Passive engagement for Participant 1 showed a median level of 13.5 with a steady (RC +2.5) and stable trend.

### **5.6.2.2 Participant 2**

Active engagement scores for Participant 2 in the intervention phase began at 26 in Session 11. This was lower than the score for the last session in the baseline phase A deterioration was then recorded for Session 12 (-14) and Participant 2's score remained steady at 14 for Session 13.

Improvements were seen for Sessions 14 (18) and 15 (42); but were followed by a deterioration to 38 in Session 16. This reverted with an improvement to 54 for Session 17, but again deteriorated to 47 in Session 18. Active engagement for Participant 2 showed a median level of 32 with an improving (RC +27.5) but variable (62.5%) trend.

Passive engagement scores for Participant 2 in the intervention phase began at 10 in Session 11. This matched the score from the last session in the baseline phase. An improvement to 16 was seen in Session 12 and a deterioration to 11 in Session 13, followed by repeated peaks and dips in Sessions 14 (18); 15 (11); 16 (19) and 17 (5), Session 18 remained steady at 6. Passive engagement for Participant 2 showed a median level of 11 with a deteriorating (RC -3.5) but variable (25%) trend.

### ***5.6.2.3 Participant 3***

Active engagement scores for Participant 3 in the intervention phase began at 0 in Session 16. This matched the score for the last session in the baseline phase. An improvement to 9 was evident in Session 17, but this reverted to 0 for Session 18 and remained steady for Sessions 19 (0) and 20 (1). An improvement to 9 was seen to Session 21 with deteriorations in Sessions 22 (6) and 23 (4). Active engagement for Participant 3 showed a median level of 2.5 with a steady (RC +2.75) but variable (25%) trend.

Passive engagement scores in the intervention phase for Participant 3 began at 3 in Session 16. This was lower than the score in the last session of the baseline phase. An improvement to 12 was evident in Session 17 but the score deteriorated to 4 for Session 18 before improving to 8 in Session 19. An improvement to 21 followed in Session 20 with a decline to 18 in Session 21, a further improvement to 32 in Session 22 and again deterioration to 15 in Session 23. Passive

engagement for Participant 3 showed a median level of 13.5 with an improving (RC +17.5) but variable (50%) trend.

#### ***5.6.2.4 Participant 4***

The active engagement score for Participant 4 in the intervention phase began at 24 in Session 21, which was higher than the score for the last session in the baseline phase. A deterioration was seen for Sessions 22 (19); 23 (10); 24 (8) and 25 (5), after which an improvement was evident in Sessions 26 (11); 27 (20) and 28 (25). Active engagement for Participant 4 showed a median level of 13 with a steady (RC 0) but variable (50%) trend.

Passive engagement scores for Participant 4 in the intervention phase began at 23 in Session 21. This was lower than the score for the last session in the baseline phase. The scores remained steady in Sessions 22 (24); and 23 (22), followed by an improvement in Sessions 24 (31) and 25 (43). This was followed by deterioration in Sessions 26 (33) and 27 (28), while the results remained steady for Session 28 (30). Passive engagement for Participant 4 showed a median level of 45 with an improving (RC +8.5) but variable (50%) trend.

#### ***5.6.2.5 Summary***

In the intervention phase for active engagement, Participant 1 showed an immediate (12) change in level between the baseline and the intervention phase (+12.5), as well as a steady (RC -0.5) and stable trend. Participant 2 did not show a change in level between the baseline and the intervention phases as the change in level recorded resulted from the increasing trend in the baseline phase (supported by a lack of immediacy, -5.6). He did however show an improving (RC +27.75) but variable (62.5%) trend. Participant 3 also did not show a change in level between the baseline and intervention phases (+1.5) (supported by a lack of immediacy, -2). She showed a steady (RC +2.75) but variable (25%) trend. For Participant 4 an immediate (7.36) change in level

was found between the baseline and the intervention phases (+4), and he showed a steady (RC -2) but variable (50%) trend. Hence participants 1 and 2 showed an improvement in active engagement. Participants 1 and 2 are the younger two participants.

In the intervention phase for passive engagement, Participant 1 did not show a change in level between the baseline and the intervention phases (-1.5) (supported by a lack of immediacy, -4.3), but he showed a steady (RC +2.5) and stable trend. Participant 2 did not show a change in level between the baseline and the intervention phases as the change in level recorded was the result of the decreasing trend in the baseline phase (supported by a lack of immediacy of -5.2). He did however show a deteriorating (RC -3.5) but variable (25%) trend. Participant 3 showed a change in level between the baseline and the intervention phases (+1.5) but this was not immediate (-4.2). She showed an improving (RC +17.5) but variable (50%) trend. Lastly, Participant 4 did not show a change in level from the baseline to the intervention phases (+5.5) as the change in level recorded resulted from the trend in the baseline phase (supported by a lack of immediacy of -2.3). He had an improving (RC +8.5) and stable trend. Hence participants 3 and 4 showed an improvement in passive engagement with the introduction of the non-powered mobility programme. Participants 3 and 4 are the older two participants.

### 5.6.3 Statistical analysis of the results for active and passive engagement

The results of the NAP analysis for active and passive engagement for each participant are presented in Table 5.3 below.

Table 5.3: Statistical analysis of active and passive engagement

Variable	Test	Participant 1	Participant 2	Participant 3	Participant 4
Active engagement	NAP	1.000***	0.688**	0.563*	0.583*
	CI at 85%		(0.393; 0.854)	(0.270; 0.760)	(0.288; 0.778)
Passive engagement	NAP	0.237*	0.163*	0.563*	0.719**
	CI at 85%	(0.014; 0.439)	(-0.012; 0.327)	(0.259; 0.764)	(0.427; 0.875)

\*NAP effect 0-0.65 weak \*\*NAP effect 0.66-0.92 medium \*\*\*NAP effect 0.93-1.00 large (Parker & Vannest, 2009)

Table 5.3 above indicates the result of the statistical analysis for active engagement and passive engagement. For participant 1 a large effect is evident for active engagement (1.000) but, a weak effect for passive engagement (0.237). For participant 2 a medium effect is evident for active engagement (0.688) with CI's of (0.393; 0.854) but, a weak effect for passive engagement (0.163). For participant 3 a weak effect for both active (0.563) and passive (0.563) engagement is evident. For participant 4 a weak effect for active engagement (0.583) but a medium effect for passive engagement (0.719) with CI's of (0.427; 0.875) is evident.

#### **5.6.4 Summary of active and passive engagement results**

As mentioned earlier, Horner et al. (2012) argue that a change in level, trend or variability as a result of the independent variable for an individual participant must be replicated with at least two other participants before an effect can be indicated in terms of a multiple probe design across participants. A summary of the results for Participants 1 to 4 is provided in Table 5.4.

Table 5.4: Summary of active and passive engagement data across Participants 1 to 4

		Participant 1		Participant 2		Participant 3		Participant 4		Therapeutic Effect	
		Baseline	Intervention	Baselin	Intervention	Baseline	Intervention	Baseline	Intervention		
		e									
Active engagement	Stable baseline		✓		✗		✓		✓	✓	
	Change in level	11	23.5	19	32	1	2.5	11	15	✗	
	Change in trend	-0.5	0.5	6.5	27.75	5	2.75	-2	0	✗	
	Change in variability (%)	20	12.5	40	62.5	20	25	0	50	✗	
	Immediacy		12		-5.6		-2		7.36	✗	
NAP (CI at 85%)			1.000***		0.688**(0.393; 0.854)		0.563*(0.270; 0.760)		0.583*(0.288; 0.778)	✗	
Passive engagement	Stable baseline		✓		✗		✓		✓	✓	
	Change in level	15	13.5	21	11	12	13.5	23.5	29	✗	
	Change in trend	-4	2.5	-7.5	-3.5	-2	17.5	2.66	8.5	✗	
	Change in variability (%)	20	0	40	25	0	50	16.7	12.5	✗	
	Immediacy		-4.3		-5.2		-4.2		-2.3	✗	
NAP (CI at 85%)			0.237*(0.014; 0.439)		0.163*(-0.012; 0.327)		0.563*(0.259; 0.764)		0.719**(0.427; 0.875)	✗	

\*NAP effect 0-0.65 weak \*\*NAP effect 0.66-0.92 medium \*\*\*NAP effect 0.93-1.00 large (Parker & Vannest, 2009)

As indicated in Table 5.4 above, a stable baseline was evident for both active and passive engagement, but no effects of intervention were found across participants.

### **5.7 Effect of non-powered, self-initiated mobility on active and passive non-engagement**

Figure 5.3 next represents the performance of Participants 1 to 4, as scored using the ICER-R (Kishida & Kemp, 2006) in the baseline, intervention and post-intervention phases. Active non-engagement and passive non-engagement are also illustrated, while a visual analysis is made of the results, including analysis of level, trend relative change and trend variability. Results are described across participants for each of the three phases of the study. Statistical analysis of the results precedes the analysis of the results across participants for effect, and this is followed by a discussion of the results.

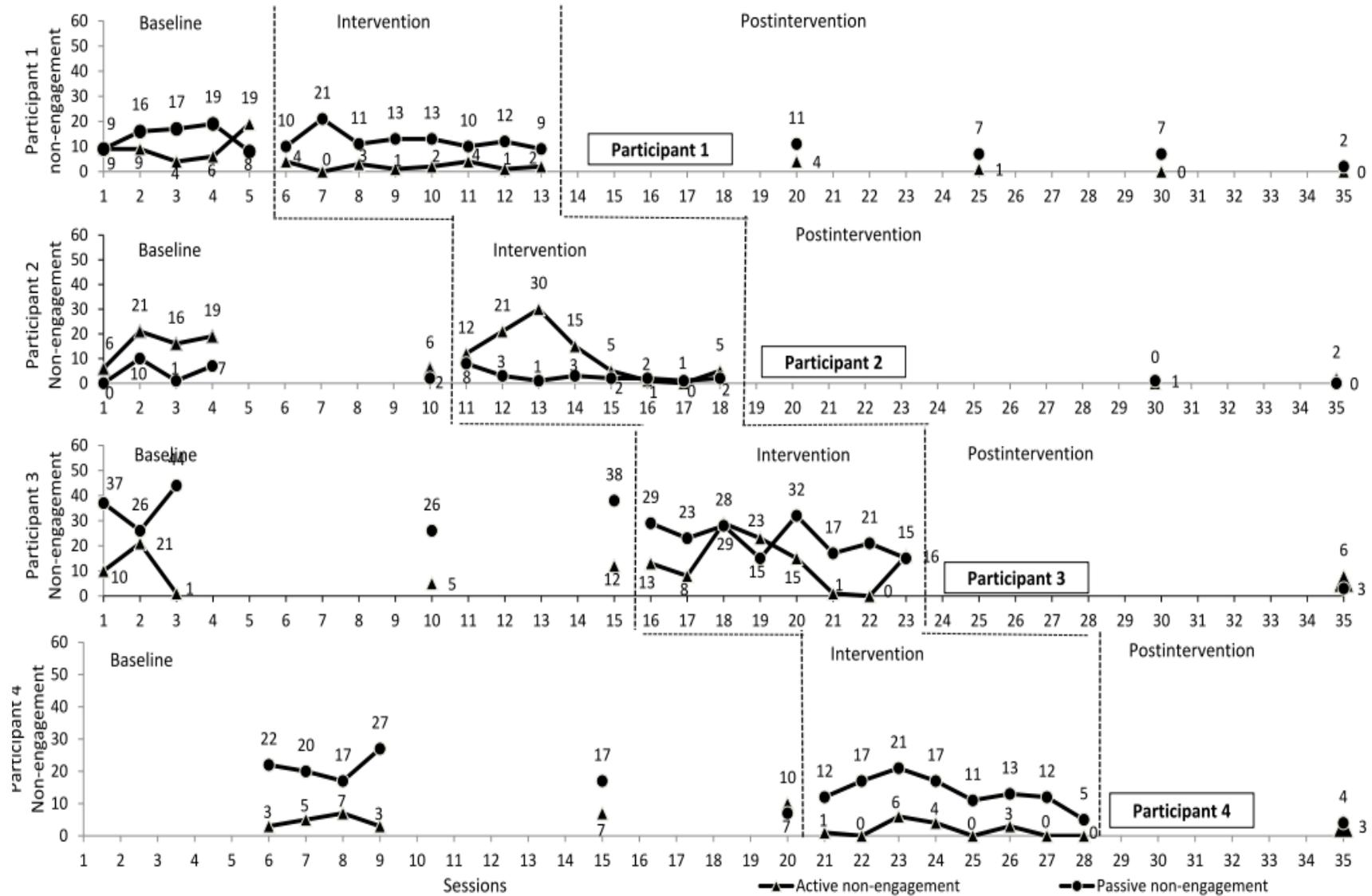


Figure 5.3 Active and passive non-engagement of Participants 1 to 4 across all phases of the study

### **5.7.1 Visual analysis of active and passive non-engagement in the baseline phase**

#### **5.7.1.1 Participant 1**

Active non-engagement scores in the baseline phase for Participant 1 began with a score of 9 in Session 1. This remained steady for Session 2 (9) but deteriorated to 4 in Session 3, where it remained steady at 6 in Session 4 before improving to 19 in Session 5. Active non-engagement for Participant 1 showed a median level of 9 with an improving (RC +3.5) and variable (40%) trend.

Passive non-engagement scores in the baseline phase for Participant 1 began with a score of 9 in Session 1. This improved to 16 in Session 2, and remained steady in Sessions 3 (17) and 4 (19). A decline to 8 then occurred in Session 5. Passive non-engagement for Participant 1 showed a median level of 17 with a steady (RC +1) and variable (40%) trend.

#### **5.7.1.2 Participant 2**

Active non-engagement scores in the baseline phase for Participant 2 opened with a score of 6 in Session 1. This was followed by an improvement to 21 for Session 2 and deterioration to 16 in Session 3. His score remained stable at 19 in Session 4 but deteriorated to 6 in Session 10. Active non-engagement for Participant 2 showed a median level of 16 with a steady (RC -1) but variable (60%) trend.

Passive non-engagement scores in the baseline phase for Participant 2 began with a score of 0 in Session 1. This improved to 10 in Session 2 and reverted to 1 in Session 3, before repeating an improvement to 7 in Session 4 and deterioration to 2 in Session 10. Passive non-engagement for Participant 2 showed a median level of 2 with a steady (RC -0.51) but variable (40%) trend.

### **5.7.1.3 Participant 3**

Active non-engagement scores in the baseline phase for Participant 3 began with a score of 10 in Session 1. This improved to 21 in Session 2 but deteriorated to 1 in Session 3. Improvement was seen in both Sessions 10 (5) and 15 (12). Active non-engagement for Participant 3 showed a median level of 12 with a deteriorating (RC -7) but variable (60%) trend.

Passive non-engagement scores in the baseline phase for Participant 3 began with a score of 36 in Session 1. This deteriorated to 26 in Session 2 and improved to 44 in Session 3. Further deterioration and improvement were evident in Sessions 10 (26) and 15 (38). Passive non-engagement for Participant 3 showed a median level of 36 with a steady (RC +1) but variable (60%) trend.

### **5.7.1.4 Participant 4**

Active non-engagement scores in the baseline phase for Participant 4 began with a score of 3 in Session 6. This remained steady for Sessions 7 (5), 8 (7), 9 (3) and 15 (7), before improving to 10 in Session 20. Active non-engagement for Participant 4 showed a median level of 6 with a steady (RC +1.66) and stable trend.

Passive non-engagement scores in the baseline phase for Participant 4 opened with a score of 22 in Session 6. This remained steady for Sessions 7 (20) and 8 (17) and improved to 27 in Session 9. A decline was evident in Sessions 15 (17) and 20 (7). His passive non-engagement scores showed a median level of 18.5 with a steady (RC -2.6) but variable (33%) trend.

### **5.7.1.5 Summary**

Active non-engagement in the baseline phase provided evidence of a stable baseline for Participant 4. Participant 1 had an improving (+3.5) baseline but variable (40%) scores, while

Participant 2 had a steady (-1) baseline but variable (60%) scores. Participant 3 had a deteriorating baseline (-7) but variable (60%) scores, and Participant 4 had a steady (+1.66) and stable baseline.

For passive non-engagement in the baseline phase, all participants showed a steady baseline, with slopes of +1, -0.51, +1 and -2.6 for Participants 1 to 4 respectively. In addition, all of the baselines were variable (40%, 40%, 60% and 33% respectively).

## **5.7.2 Visual analysis of active and passive non-engagement in the intervention phase**

### **5.7.2.1 Participant 1**

Active non-engagement scores for Participant 1 in the intervention phase began at 4 in Session 6. This was lower than the score for the last session in the baseline phase. A decline to 0 was seen in Session 7, after which steady scores were evident in Sessions 8 (3), 9 (1), 10 (2), 11 (4), 12 (1) and 13 (2). Active non-engagement for Participant 1 showed a median level of 2 with a steady (RC+0.25) and stable trend.

Passive non-engagement scores for Participant 1 in the intervention phase began at 10 in Session 6, which matched the score for the last session in the baseline phase. An improvement to 21 was then evident in Session 7, but this reverted to 11 in Session 8 and remained stable in Sessions 9 (13), 10 (13), 11 (10), 12 (12) and 13 (9). Passive non-engagement for Participant 1 showed a median level of 12.5 with a steady (RC -2.75) and stable trend.

### **5.7.2.2 Participant 2**

Active non-engagement scores for Participant 2 in the intervention phase began at 12 in Session 11. This was higher than the score for the last session in the baseline phase. Improvement was evident in Sessions 12 and 13 to 21 and 30 respectively, before deterioration in Sessions 14 (15), 15 (5) and 16 (1). Scores for Session 17 remained stable at 0 and improved to 5 for Session

18. Active non-engagement for Participant 2 showed a median level of 8.5 with a deteriorating (RC -16.5) but variable (50%) trend.

Passive non-engagement scores for Participant 2 in the intervention phase began at 8 for Session 11. This was higher than the score for the last session in the baseline phase. A deterioration to 3 was evident in Session 12 and steady results were obtained for Sessions 13 (1), 14 (3), 15 (2), 16 (2), 17 (1) and 18 (2). Passive non-engagement for Participant 2 showed a median level of 2 with a steady (RC -0.51) and stable trend.

### ***5.7.2.3 Participant 3***

Active non-engagement scores for Participant 3 in the intervention phase began at 13 in Session 16. This matched the score for the last session in the baseline phase. A decline to 8 was evident in Session 17, which was followed by an improvement to 29 in Session 18. Further deterioration was evident in Sessions 19 (23), 20 (15), and 21 (1). A steady score of 0 was maintained in Session 22 before an improvement to 16 in Session 23. Active non-engagement for Participant 3 showed a median level of 14 with a deteriorating (RC -10) and variable (37.5%) trend.

Passive non-engagement scores for Participant 3 in the intervention phase began at 29 in Session 16. This was lower than the score for the final session in the baseline phase. A decline to 23 was seen in Session 17 and an improvement to 28 in Session 18, while further deterioration and improvement occurred in Sessions 19 (15) and 20 (32) respectively, followed by a deterioration to 17 in Session 21. A steady result of 21 was evident in Session 22 before her score again deteriorated to 15 in Session 23. Passive non-engagement for Participant 3 showed a median level of 22 with a steady (RC -2.5) but variable (25%) trend.

### ***5.7.2.4 Participant 4***

Active non-engagement scores for Participant 4 in the intervention phase began at 1 in Session 21. This was lower than the score for the last session in the baseline phase. The score remained steady at 0 in Session 22 but improved to 6 in Session 23. The score remained steady at 4 in Session 24, before reverting to 0 in Session 25 and remaining steady for Sessions 26 (3), 27 (0) and 28 (0). Active non-engagement for Participant 4 showed a median level of 0.5 with a steady (RC -2) but variable (25%) trend.

Passive non-engagement scores for Participant 4 in the intervention phase began at 12 in Session 21. This was higher than the score for the final session in the baseline phase. Improvement was seen in Sessions 22 (17) and 23 (21), followed by deterioration in Sessions 24 (17) and 25 (11) and remaining steady in Sessions 26 (13) and 27 (12). A decline to 5 occurred in Session 28. Passive non-engagement for Participant 4 showed a median level of 12.5 with a deteriorating (RC -6.5) but variable (37.5%) trend.

#### **5.7.2.5 Summary**

In the intervention phase for active non-engagement, Participant 1 showed an immediate (-7.3) change in level between the baseline and the intervention phases (-7). He showed a steady (-2.75) and stable trend. Participant 2 also showed a change in level between the baseline and the intervention phases (-7.5) that was immediate (7.4), as well as a steady (-2) and stable trend. Participant 3 showed an immediate (10.66) change in level between the baseline and the intervention phases (+2), and recorded a steady but variable (25%) trend. Participant 4 showed a change in level between the baseline and the intervention phases (-5.5), but this was not shown to be immediate (-4.26). He furthermore showed a deteriorating (-6.5) and variable (37.5%) trend.

In the intervention phase for passive non-engagement, Participant 1 showed a change in level between the baseline and the intervention phases (-4.5) which was not shown to be

immediate (-0.60). He showed a steady (-2.75) and stable trend. Participant 2 did not show a change in level between the baseline and the intervention phases (0) (confirmed by a lack of immediacy, -0.7), but he also showed a steady (-2) and stable trend. For Participant 3, an immediate (-9.33) change in level occurred between the baseline and the intervention phases (-14) and she showed a steady (-2.5) but variable (25%) trend. Participant 4 showed a change in level between the baseline and the intervention phases (-6), but this was shown to not be immediate (-0.33). He showed a deteriorating (-6.5) but variable (37,5%) trend.

### 5.7.3 Statistical analysis of active and passive non-engagement

The results obtained from the NAP analysis for active and passive non-engagement by each of the four participants are presented in Table 5.5 below.

*Table 5.5: Statistical analysis of active and passive non-engagement*

Variable	Test	Participant 1	Participant 2	Participant 3	Participant 4
Active non-engagement	NAP	0.975***	0.663**	0.388*	0.875**
	CI at 85%	(0.865; 0.996)	(0.364; 0.838)	(0.120; 0.603)	(0.655; 0.958)
Passive non-engagement	NAP	0.538*	0.488*	0.850**	0.750**
	CI at 85%	(0.152; 0.781)	(0.142; 0.727)	(0.570; 0.953)	(0.444; 0.899)

*\*NAP effect 0-0.65 weak \*\*NAP effect 0.66-0.92 medium \*\*\*NAP effect 0.93-1.00 large (Parker & Vannest, 2009)*

Table 5.5 above indicates the result of the statistical analysis for active and passive non-engagement. Participant 1 showed evidence of a strong effect for active non-engagement (0.975) with CI's of (0.865; 0.996) but, a weak effect for passive non-engagement (0.538). Participant 2 showed evidence of a medium effect for active non-engagement (0.663) with CI's of (0.364; 0.838) but a weak effect for passive non-engagement (0.488). Participant 3 showed evidence of a weak effect for active non-engagement (0.388) but a medium effect for passive non-engagement (0.850) with CI's of (0.570; 0.953). Participant 4 showed a medium effect for both active (0.875) and passive (0.750) non-engagement with CI's of (0.655; 0.958) and (0.444; 0.899) respectively.

#### **5.7.4 Summary of active and passive non-engagement results**

As stated repeatedly before, Horner et al. (2012) argue that a change in level, trend or variability as a result of the independent variable for an individual participant must be replicated with at least two other participants before an effect can be indicated in terms of a multiple probe design across participants. The size of this effect can then be determined by means of statistical analysis. A summary of the results for Participants 1 to 4 is next provided in Table 5.6.

Table 5.6: Summary of active and passive non-engagement data across Participants 1 to 4

		Participant 1		Participant 2		Participant 3		Participant 4		Therapeutic Effect
		Base line	Intervention	Baseline	Intervention	Baseline	Intervention	Baseline	Intervention	
Active non-engagement	Stable baseline		✘		✘		✘		✓	✘
	Change in level	9	2	16	8.5	12	14	6	0.5	✓
	Change in trend	+3.5	+0.25	-1	-16.5	-7	-10	+1.66	-2	✘
	Change in variability (%)	40	0	60	50	60	37.5	20	25	✘
	Immediacy		-7.3		7.4		10.66		-4.26	✘
	NAP (CI at 85%)	0.975***	(0.865; 0.996)	0.663**	(0.364; 0.838)	0.388*	(0.120; 0.603)	0.875**	(0.655; 0.958)	✓
Passive non-engagement	Stable baseline		✘		✘		✘		✘	✘
	Change in level	17	12.5	2	2	36	22	18.5	12.5	✓
	Change in trend	+1	-2.75	-0.51	-2	+1	-2.5	-2.6	-6.5	✘
	Change in variability (%)	40	12.5	40	12.5	60	25	33.3	37.5	✓
	Immediacy		-0.6		-0.7		-9.33		-0.33	✘
	NAP (CI at 85%)	0.538*	(0.152; 0.781)	0.488*	(0.142; 0.727)	0.850**	(0.570; 0.953)	0.750**	(0.444; 0.899)	✘

\*NAP effect 0-0.65 weak    \*\*NAP effect 0.66-0.92 medium    \*\*\*NAP effect 0.93-1.00 large (Parker & Vannest, 2009)

As indicated in Table 5.6 above, effects due to the introduction of non-powered, self-initiated mobility are lacking for both active and passive non-engagement.

For active non-engagement, only Participant 4 showed a stable baseline. This was followed by an effect of change in level for all participants. The change in level indicated deterioration of -7, -7.5, and -5.6. for participants 1, 2 and 4 respectively, and an improvement of 2 for Participant 3. The statistical analysis provided evidence of a strong effect using the NAP for participant 1 (0.975), and medium effect for for participants 2 (0.663) and 4 (0.875).

For passive non-engagement, none of the participants showed a stable baseline. An effect of change in level was however evident for Participants 1, 3 and 4. The change in level indicated a deterioration of -4.5, -14 and -6 respectively, but the effect of change in level was not supported by an effect in immediacy. An effect of change in variability was also measured for Participants 1, 2 and 3, and proved to be a decrease of 27,5%, 27,5% and 35% respectively.

### **5.8 Age and effect on changes in engagement as a result of the non-powered mobility programme**

The results on the effect of the non-powered mobility programme as described in this chapter provided evidence of differences in results between the participants. As other authors have identified age as a factor influencing engagement (de Kruif & McWilliam, 1999), an analysis of the effect of the non-powered mobility programme on engagement and the age of the participants was conducted. The results of this analysis are indicated in Table 5.7 and described below.

*Table 5.7: Age of participants and effect of the non-powered mobility programme on engagement*

Age	Effect on Engagement	Effect on non-engagement	Effect on active engagement	Effect on passive engagement	Effect on active non-engagement	Effect on passive non-engagement
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	Age	Effect on Engagement	Effect on non-engagement	Effect on active engagement	Effect on passive engagement	Effect on active non-engagement	Effect on passive non-engagement
Participant 1	3y 1m	✓	✓	✓	✗	✓	✗
Participant 2	2y 10m	✗	✗	✓	✗	✓	✗
Participant 3	5y 4m	✓	✓	✗	✓	✗	✓
Participant 4	6y 9m	✓	✓	✗	✓	✗	✓

As shown in Table 5.7, changes in engagement and non-engagement were evident for participants 1, 3 and 4. Active and passive engagement however showed reverse patterns with participants 1 and 2 (younger) showing increased active engagement and participants 3 and 4 (older) showing increased passive engagement. A similar pattern was evident for non-engagement.

### 5.9 Summary of results

This chapter described the results of this study. To begin with the response of the participants to the intervention programme was introduced. This described how all participants made use of self-initiation of mobility during the programme although they were not yet fully independent in their use of mobility. The effect of the non-powered mobility programme on engagement was then presented. An effect on both engagement and non-engagement was evident on the introduction of the non-powered mobility programme. Within engagement and non-engagement no effect of the introduction of the non-powered mobility programme was evident for either active or passive engagement or active and passive non-engagement. The chapter concluded with a comparison of the age of the participants and their engagement results which indicated that the younger participants showed a change in active engagement and the older participants showed a change in passive engagement.

## CHAPTER 6: DISCUSSION

### 6.1. Introduction

This chapter discusses the results presented in Chapter 5 in view of the Model of Change in Motor Abilities and Engagement in Self-care and Play of Young Children with CP (Chiarello et al., 2011) that was presented in Section 2.4. First, the results relating to body structures and functioning are discussed, followed by those relating to associated conditions. Finally, the results relating to adaptive behaviour are discussed. Within each discussion, the results are compared to those from other studies.

### 6.2. Discussion of results in relation to the Model of Change in Motor Abilities and Engagement

In the model of Chiarello et al. (2011) (see Section 2.4), engagement is seen to be closely related to gross motor abilities. The results of the current study indicated an improved level of engagement for Participants 1, 2, 3, and 4 following the introduction of non-powered, self-initiated mobility. These results support the model of change in motor abilities with change in engagement, seeing that a change in engagement (improvement) was noted when mobility (a motor ability) was introduced. Similarly, Participants 1, 2, 3 and 4 recorded a decline in their level of non-engagement from the baseline to the intervention phase. This also supports the Chiarello et al.'s (2011) model, as the change in motor abilities caused a change in non-engagement (deterioration). Although, as depicted in the model, a change in motor abilities resulted in the change in engagement, it is postulated that a variety of factors intrinsic to the child and environment were involved in this process. The child factors to be discussed are presented in Table 6.1, but since the environmental factors were not within the scope of the current study, they will not be commented on.

*Table 6.1: Areas of the Model of Change in Motor Abilities and Engagement addressed in the discussion*

Area from the Model of Change in Motor Abilities and Engagement	Factor discussed
Characteristics relating to body structure and functioning	<ul style="list-style-type: none"> <li>• Motor skill learning</li> <li>• Gross motor skills</li> <li>• Age</li> </ul>
Associated conditions and co-morbidities	<ul style="list-style-type: none"> <li>• Epilepsy</li> </ul>
Adaptive behaviour	<ul style="list-style-type: none"> <li>• Learned helplessness</li> </ul>
Environmental factors	Not discussed

Table 6.1 indicates the areas within the Model of Change in Motor Abilities and Engagement (Chiarello et al., 2011) that are dealt with in this discussion. Motor skill learning, gross motor skills and age are discussed in the area of characteristics of body structures and functioning. In the area of associated conditions and co-morbidities, epilepsy is discussed. In the area of adaptive behaviour, learned helplessness is discussed. No environmental factors are discussed.

### 6.3. Child factors

#### 6.3.1. Body structures and functioning

On examining the results of this study, it became evident that improvements in engagement and deteriorations in non-engagement occurred for all participants. However, although the level of engagement for all participants was improved, the graphic presentation of the data shows that all participants actually showed a deterioration in engagement when the non-powered mobility programme was introduced, before an improvement was seen. For Participant 1 this decline lasted two sessions, but for Participants 2, 3 and 4 the decline continued for three sessions. A possible explanation for the deterioration noted may be related to the process of learning new motor skills. When the non-powered mobility programme was introduced, the participants were in the initial stages of skill learning, which requires a significant focus on the motor skill learning process. This may have detracted the participants from a focus on play. As engagement was measured in the course of play in this study, a shift of focus onto motor skill learning may have caused engagement

in play to deteriorate. This deterioration only reverted once the children's motor skills required for mobility improved, and their focus reverted to play.

The processes that may be involved in the shift of focus from play to motor skill learning and then back to play are described in Willingham's motor control processes (presented in Section 4.2) as part of motor control theory. In the latter theory, both declarative (conscious) and procedural (unconscious) learning are involved in motor skill learning. Willingham describes the two learning strategies as complementary, and specifies that where one process is limited, the other is able to compensate. For instance, for children with severe motor impairment, the learning of motor skills through procedural (unconscious) processes does not typically progress as anticipated, due to challenges such as increased muscle tone, sensory involvement and other intrinsic factors. However, Willingham proposes that through the use of declarative (conscious) learning, some of these deficits could be overcome using alternative input such as cognitive and language strategies (1998). The use of either declarative or procedural learning is nonetheless neither fixed nor exclusive. As motor skill learning is initiated using declarative strategies, procedural strategies do not cease but are continued until such point as the motor skill can be applied unconsciously and the declarative strategies are no longer needed (Willingham et al., 2002). While declarative strategies are in use, a focus on motor learning is required, which diverts the child's attention from other activities such as play. Once procedural learning becomes the dominant process, the focus of the child can revert from motor skills back to other areas, which for this study was play.

Further examination of the results of this study reveals another area for discussion, namely active and passive engagement. In comparing the results of the participants in this study, two patterns of change in engagement were seen to emerge. For Participants 1 and 2, an increase in

active engagement occurred, while passive engagement remained stable. In contrast an increase in passive engagement was recorded for Participants 3 and 4, while active engagement remained stable. This result – when considered in relation to the Model of Change in Motor Abilities and Engagement in Self-care and Play of Children with CP (Chiarello et al., 2011) – suggests that the change in motor abilities that resulted from the introduction of the non-powered mobility programme was different for Participants 1 and 2 and Participants 3 and 4. Hence, different changes in engagement for the participants were revealed.

A factor that may have resulted in this pattern of results is the level of gross motor functioning of the participants in this study. Although all the participants were found to be functioning at a GMFCS level V (Palisano et al., 1997), the actual descriptions of the participants indicate that on this level, two patterns of movement were present. The first pattern (for Participants 1 and 2) was one in which the children were able to initiate movement of their limbs with ease. For Participants 3 and 4, the initiation of movement was much more difficult and observed less often. Based on the descriptions of the participants (Section 3.7) and the results (Chapter 5), it is proposed that Participants 1 and 2 who were more active, had greater motor functioning and a higher level of engagement (active engagement) than Participants 3 and 4. In contrast, Participants 3 and 4 had more severe problems with motor functioning, and this resulted in a lower level of engagement (passive engagement) than Participants 1 and 2. These results corroborate those of Beckung and Hagberg (2002), as well as Voorman et al. (2006), who performed large-scale studies on the factors that have an impact on the participation of children with impairments. Both of these studies indicated that motor impairments were significant factors in participation, and suggested that the more severe the impairment, the greater the impact on participation.

In spite of motor skill learning and gross motor level of functioning providing support to the existing literature on engagement, an area that provided a contradiction to existing literature was that of age. The results of active engagement for the participants indicated that Participant 2, who was the youngest, reached the highest levels of active engagement, followed by Participant 1, who was the second youngest. Participant 4, who was the oldest showed the third highest active engagement and Participant 3, who was third in age, had the lowest active engagement. A reverse pattern was evident for passive engagement, with Participant 4 having the highest passive engagement, followed by Participants 3, 1 and 2 (in that order). Since active engagement is a higher level of engagement than passive engagement, overall engagement was highest for Participant 2 (youngest). He was followed by Participant 1 (second youngest), then Participant 4 (oldest) and Participant 3 (third youngest) who had the lowest overall engagement. Studies by McWilliam and Bailey (1990; 1995) provided evidence that age was related to engagement, with younger children having lower engagement than their older peers. For children with disabilities, a similar pattern was seen, but the overall engagement for children with disabilities was lower than that of their peers, even when corrections for developmental age were applied. These results are not supported by the current study.

In considering the reasons for the apparent contradiction of results between this study and those of McWilliam and Bailey (1990, 1995), a possible explanation may be that the developmental level of the participants differed and was independent of their age. Casey, McWilliam and Simms (2012) considered the contribution of the developmental level to engagement, rather than age. Their study on preschoolers with disabilities indicates that the developmental level of the children is a strong predictor of their engagement. Although in the current study developmental level was not measured, the descriptions of functional abilities

provided by the caregivers showed that the participants with higher functional abilities had higher engagement scores. Participant 2 had both the highest engagement score and the most words (5) and he was reported to play actively with objects through kicking. Participant 1 with the second highest engagement score had only one word and played through touching objects. In contrast, Participants 4 and 3 who had the lowest engagement scores had no words and were both reported to watch play, rather than to be actively involved. These results imply that functional abilities may be a more significant factor in engagement than chronological age.

Both gross motor impairment and functional abilities have been postulated as possible reasons for the differences in active and passive engagement between participants, as indicated in the results. It is, however, quite likely that the combination of the severity of gross motor impairment and functional abilities resulted in the reduced engagement for the Participants 4 and 3, in comparison to Participants 1 and 2.

### **6.3.2. Associated conditions and co-morbidities**

When the results were examined, it became evident that for Participant 3 the associated condition of epilepsy had an impact on her engagement. The effect of epilepsy on her engagement was evident in Sessions 18 and 23 when Participant 3 was noted to have seizures. During these sessions, the effect of the seizures caused an increase in active non-engagement. In Session 18, Participant 3 was able to continue the intervention following her seizure, but in Session 23 her seizure was greater and she was unable to continue intervention. For children with severe motor impairment, co-occurring conditions such as seizures are common (Koman, Smith, & Shilt, 2004) and may disrupt ongoing learning processes. For Participant 3 decreases in engagement followed in the sessions when seizures occurred, and increases in non-engagement. These results support the evidence provided by Voorman et al. (2006) in their study on the participation of children with

cerebral palsy. They found evidence that epilepsy was a strong factor affecting communication and social life, along with cognitive impairment. For Participant 3, whose play was described as more social than object focused, the seizures affected her communication and social life to a greater extent.

### **6.3.3. Adaptive behaviour**

In the Model of Motor Change and Engagement in Self-care and Play of Children with CP (Chiarello et al., 2011), adaptive behaviour is described as behaviours used to meet personal needs and respond to and interact with the environment. Adaptive behaviours are typically related to personal independence and social responsibility (Sparrow, Balla, & Cicchetti, 1984). As part of the current study, the adaptive behaviour of learned helplessness, which relates to personal independence, will be discussed.

The results of this study provide evidence that Participants 3 and 4 were more passively engaged, while Participants 1 and 2 were more actively engaged. As postulated previously, the severity of their physical impairment may have resulted in this difference for the participants. However, an adaptive behaviour that is linked to severity of motor impairment and that may have compounded the effect of the motor impairment for these children is that of learned helplessness (Abramson et al., 1978). Learned helplessness is described as a decrease in motivation as a result of unreliable results when initiating movements. In terms of the Model of Change in Motor Abilities and Engagement in Self-care and Play of Children with CP (Chiarello et al., 2011), a decrease in motivation as a result of learned helplessness would affect both change in motor abilities and engagement for a child. For the participants in this study, two factors that had an impact on the effect of learned helplessness on engagement are evident: Firstly, the severity of motor impairment, with greater impairment increasing the unreliability of results; and secondly,

age and the length of time for which participants have been involved in the cycle of demotivation. The results of this study indicate that Participants 1 and 2, who had the lowest risk of learned helplessness based on their severity of motor impairment and age, indeed presented with higher engagement scores than Participants 3 and 4 who were at greater risk. These results support the links between engagement, motivation and perseverance as described in a study on the persistence at tasks of young children (Yarrow et al., 1982), in which the persistence of infants to master tasks was considered. Their study provided evidence that increased success leads to increased persistence. Learned helplessness causes a reversal of this effect. Uncontrollability leads to decreased motivation and decreased persistence, and the longer this continues, the greater the impact. Based on these results, it may be possible to purport that more severe learned helplessness (as a result of greater severity of motor impairment), as well as longer time spent in learned helplessness reduces the engagement possible for young children.

#### **6.4. Conclusion**

In conclusion, the results of this study provide evidence that points to child factors being involved in the changes in engagement observed in this study. In this regard, severity of gross motor impairment, functional abilities, epilepsy and learned helplessness were all postulated to have an impact on the engagement of the participants. Although severity of gross motor impairment, functional abilities and learned helplessness are discussed individually, it is acknowledged that in the presence of severe motor impairment, the three may be integrally linked.

## CHAPTER 7: CONCLUSIONS, EVALUATION AND RECOMMENDATIONS

### 7.1. Introduction

This chapter contains a summary of the research and conclusions regarding the effect that non-powered, self-initiated mobility has on engagement for young children with severe motor impairments. It contains a discussion of the clinical implications of the study and evaluates the strengths and weaknesses of the study. The chapter concludes with suggestions for future research.

### 7.2. Summary of the study

The purpose of this research was to describe the effect of non-powered, self-initiated mobility on the engagement of young children with severe motor impairment in play activities, based on the results of a probe test. All four participants involved provided evidence of an improvement in *engagement* and deterioration in *non-engagement* when the intervention was introduced. Although an effect of change was not recorded in either active or passive *engagement*, an effect of change was recorded in both active and passive *non-engagement*.

From these results it was concluded that the implementation of non-powered, self-initiated mobility improved engagement for all participants. The lack of effect recorded in active and passive engagement was postulated to be due to differences between the participants in respect of gross motor skills, functional abilities and learned helplessness. This postulation was supported by the existing literature, which correlated severity of motor impairment and functional ability, with level of engagement, as well as learned helplessness with decreased engagement.

### **7.3. Clinical implications of the study**

The most important clinical finding that emerged from this study is that a two-week intensive non-powered mobility programme was able to provide sufficient non-powered, self-initiated mobility for an improvement in the engagement of young children with severe motor impairments to be measured. For clinicians, improved engagement provides greater opportunities for development during experiences and an increase the number of opportunities for success and development. Furthermore, the study identified improvements in engagement within a short period of time (8 ½ hour sessions) when the non-powered mobility programme was used – even though no additional practice occurred outside of the intervention. Clinically this is critical as even if the lack of mobility is temporary for a child, the effect of learned helplessness can have lasting effects. By introducing the non-powered, self-initiated mobility device as early as possible the effects of learned helplessness and a lack of access can be mitigated.

Another clinical implication of this study is that the introduction of non-powered, self-initiated mobility provided an alternative to powered mobility for young children with motor impairment. The non-powered, self-initiated mobility device is a cost-effective device for young children and can be used as an interim solution to provide mobility while a permanent solution is sought.

### **7.4. Evaluation of the study**

The study has been evaluated in terms of both strengths and weaknesses and these will be discussed next.

#### **7.4.1. Strengths**

This study was the first of its kind targeting non-powered, self-initiated mobility for children with severe motor impairment. Procedural integrity was maintained through the use of i) general procedural scripts and ii) a prompt hierarchy during play. The general procedural scripts provided multiple options for behaviours from the participant. This allowed the researcher flexibility in her responses, while maintaining the input at the same level for all participants. The prompt hierarchy was used to provide prompts for motor skill learning in a systematic way during the intervention. The prompt hierarchy ensured that a structured and sequential process was followed in the teaching of motor skills. The participants appeared to be interested in the toys that were provided, and found them enjoyable and sufficiently motivating to encourage the children to try to make use of the non-powered, self-initiated mobility device.

In this study, the use of the ICER-R (Kishida & Kemp, 2009), a standardised measure of engagement, was shown to be an effective tool for measuring engagement among children with severe motor impairment. Furthermore, making video recordings of the administration of the ICER-R (Kishida & Kemp, 2009) allowed for probe tests to be conducted after the session; the probe test could therefore have no impact on the child's behaviour.

The use of four participants in a multiple probe design across participants provided experimental control for the study, as it met the minimum number of participants required for an effect to be measured (Ferron et al., 2011; Gast, 2010; Murphy & Bryan, 1980).

A further strength of this study was its procedural integrity (between 93% and 97%), which was measured using a checklist based on the general procedures script and prompt hierarchy. The reliability of data measured with the ICER (Kishida & Kemp, 2009) also indicated good inter-rater and intra-rater reliability, as no significant differences were noted.

Using play as medium of intervention provided a context that could be repeated easily, both at home and during intervention. The intervention was also scripted in terms of general procedures and a prompt hierarchy, both of which allow for the replication of the study in different contexts.

The fact that a cost-effective non-powered mobility device could be easily constructed using available materials proved to be a further strength of this study, especially for low-resource countries.

#### **7.4.2. Limitations**

The limitations in the multiple probe design across participants are noted. Within this design, intra-subject replicability of results is not possible. Furthermore, the multiple probe design makes use of non-continuous data collection, which provides fewer opportunities to measure the dependent variable. This design was nonetheless selected due to the irreversibility of the dependent variable.

A combination of purposive and convenience sampling was used to select participants. Although participants had to display a specific profile (purposive sampling), those who attended the rehabilitation centre were conveniently accessible to the researcher (convenience sampling). However, these factors limit the external validity of the study.

The fact that a limit of four sessions per skill taught was set as teaching criterion may have ended training on each skill prior to the participant having benefited adequately from such intervention. The use of a learning criterion, that would have ensured that the participants were fully independent in each skill area, prior to moving on to the next, and would have strengthened the study.

A final limitation of this study is that only engagement was measured. Congruent measures of motor skills were not measured due to the limited intervention period (2 weeks), as it was postulated that the limited time would not be sufficient to see gains in the developmental domain.

### **7.5. Recommendations for future research**

Recommendations for future research that have emanated from the study include the following:

- Investigating the effect of non-powered mobility on engagement by using a multiple baseline design across behaviours and replicated across participants would strengthen the validity of the study. The effect of powered mobility on engagement could also be measured using a similar design.
- Describing and comparing the effects that a non-powered, self-initiated mobility device and a powered mobility device may have on engagement. A non-equivalent group design could be used.
- Investigating the effect of non-powered mobility on different developmental domains (gross motor, fine motor, cognitive, communication, etc.). A pretest-posttest group design (with a control group) could be used.

### **7.6. Summary**

Chapter 7 summarises the results of the research as described in Chapter 5 and the discussions in Chapter 6. This is followed by a discussion of the clinical implications of the study. Finally, the study as a whole is evaluated in terms of its strengths and limitations, before suggestions for future research are made.

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## Appendix A

### GMFCS family report questionnaire in English and isiZulu

#### **GMFCS Family Report Questionnaire:**

Children Aged 2 to 4 Years

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Available from CanChild Centre for Childhood Disability Research ([www.canchild.ca](http://www.canchild.ca)), McMaster University

GMFCS modified with permission from Palisano et al. (1997) Dev Med Child Neurol, 39, 214-223.

Please read the following and mark only one box beside the description that best represents your child's movement abilities.

My child...

- Has difficulty controlling head and trunk posture in most positions and uses specially adapted seating to sit comfortably and has to be lifted by another person to move about
- Can sit on own when placed on the floor and can move within a room and uses hands for support to maintain sitting balance and usually uses adaptive equipment for sitting and standing and moves by rolling, creeping on stomach or crawling
- Can sit on own and walk short distances with a walking aid (such as a walker, rollator, crutches, canes, etc.) and may need help from an adult for steering and turning when walking with an aid and usually sits on floor in a "W-sitting" position and may need help from an adult to get into sitting and may pull to stand and cruise short distances and prefers to move by creeping and crawling
- Can sit on own and usually moves by walking with a walking aid and may have difficulty with sitting balance when using both hands to play and can get in and out of sitting positions on own and can pull to stand and cruise holding onto furniture and can crawl, but prefers to move by walking
- Can sit on own and moves by walking without a walking aid and is able to balance in sitting when using both hands to play and can move in and out of sitting and standing positions without help from an adult and prefers to move by walking

## **Iphepha lemibuzo le-GMFCS elinoMbiko ngoMndeni:**

Abantwana abaphakathi kweminyaka emi-2 kuya kwemi-4

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Sicela ufunde okulandelayo bese ufake uphawu ebhokisini elilodwa kuphela ecaleni kwencazelo echaza amandla okunyakaza komntwana wakho.

Umntwana wami...

- Unobunzima bokulawula ikhanda nokuqondisa izingxenye eziningi zomzimba futhi usebenzisa izindlela ezakhelwe yena ukuze ahlale ngokukhululeka futhi kumele aphakanyiswe omunye umuntu ukuze aye kwezinye izindawo
- Uyakwazi ukuzihlalela phansi futhi uyakwazi ukuhamba endlini futhi usebenzisa izandla ukuze abambelele uma ehlala futhi uvame ukusebenzisa okuthile okusizayo ukuze ahlale nokuthi ame futhi uhamba ngokugingqika, ukuhuhuluza ngesisu noma ngokugaqa
- Uyakwazi ukuzihlalela futhi ahambe amabanga amafushane ngokusebenzisa insiza ukuze ahambe (okufana ne-walker, i-rollator, izinduku, udondolo, njll.) futhi angase adinge usizo lomuntu omdala ukuze ajikise futhi ajike uma ehamba ngensiza yokuhamba futhi uvame ukuhlala phansi ngendlela yokuphambanisa izinyawo kwakheke u“W-” futhi angase adinge usizo lomuntu omdala ukuze ahlale futhi angadonsa okuthile ukuze ame futhi ashwibeke kumabanga amafushane futhi ukhetha ukuhamba ngokuhuhuluza nokugaqa
- Angakwazi ukuzihlalela ngokwakhe futhi uvame ukuhamba ngensiza yokuhamba futhi angase abe nenkinga yokuhlala angawi uma edlala ngezandla zombili futhi uyakwazi ukushintshashintsha izindlela zokuhlala ngokwakhe futhi angadonsa noma ashwibeke ngokubambelela kwimpahla yasendlini futhi angagaqa, kodwa ukhetha ukuhamba ngezinyawo
- Angazihlalela ngokwakhe futhi uhamba ngaphandle kwensiza yokuhamba futhi ukwazi ukuhlala angawi uma edlala ngezandla zombili futhi ukwazi ukushintshashintsha izindlela zokuhlala nezokuma ngaphandle kokusizwa umuntu omdala futhi ukhetha ukuhamba ngezinyawo

## Appendix B

### ICER-R manual and Score sheet

#### ***The Individual Child Engagement Record - Revised*** **ICER-R Manual**

Yuriko Kishida and Coral Kemp (2009)

#### Contents:

1. Instructions
2. Definitions and Examples of Behaviours
3. Additional Rules
4. References

## 1. INSTRUCTIONS

**Section A.** Record information required.

**Section B: Direct Observation of the Child.**

1. Study each definition of coding.
2. Use a set of earphones and an audio player (e.g., a CD player or a MP3 player) which provides a tone every 15 seconds.
3. Start playing the audio player. When you hear the first tone, record the engagement type, and whether or not there is an interaction, and/or a physical prompt. You are required to code for 'Interaction Partner' only if you observe an interaction (i.e., only when you slash 'Yes' for 'Occurrence of Interaction'). You may select either "A" for adult or "P" for peer, or both, based on what you observed at the moment you hear the tone. Slash the code that you observed and circle the code if the target child directs aggressive or intrusive verbal or physical nonengaged behaviour towards others, both children and adults. Should time permit, you may briefly record qualitative information in the column provided.

**Section C.** Comment on the observation in relation to the behaviours of the target child, adults and peers or activities.

**Section D.** Complete the rating scales.

***Note for Abbreviations and Symbols***

*Engagement Type*

AE: Active Engagement, PE: Passive Engagement, AN: Active Nonengagement, PN: Passive Nonengagement

*Interaction*

A: Adults, P: Peers

***Rules for Coding***

**1. Engagement over Nonengagement**

If *Engagement* and *Nonengagement* are observed simultaneously, choose *Engagement*.

**2. Active over Passive**

If *Active* behaviours and *Passive* behaviours are observed simultaneously, choose *Active* behaviours.

***Tips for Coding***

1. Decide whether the child is *Engaged* or *Nonengaged* first, then decide whether the behaviour is *Active* or *Passive*.
2. If you think that the child is *Nonengaged* in the behaviour expected in the specific context, code the behaviour as *Nonengagement* then judge whether the behaviour is *Active* or *Passive*.
3. If you think that you/the teacher would not want the child to continue the behaviour because the child is less likely to learn something appropriate from the behaviour,

code it as *Nonengagement* (adapted from de Kruif & McWilliam, 1998, E-Qual III Additional Coding Rules:12)

## 2. DEFINITIONS AND EXAMPLES OF BEHAVIOURS

### Active Engagement

The child actively participates in the activity by interacting with the learning environment appropriately by manipulating materials or vocalising. The child does not demonstrate repetitive behaviours.

#### *Examples of Active Engagement*

- (a) During free play the child holds and moves the brush with his/her eyes on the brush and paper in order to paint.
- (b) During mealtime the child talks with friends and/or eats.
- (c) During group time, the child replies either orally or by gestures (e.g., pointing) to a teacher's question.

#### *Nonexamples of Active Engagement*

- (a) The child holds the brush, but does not move it. The child looks at the paint on the table (Code as *PE*).
- (b) During story time the child talks with a friend (Code as *AN*).
- (c) The child refuses to go to bathroom either verbally or by use of gestures when a teacher asks to him/her to wash his/her hands (Code as *AN*).
- (d) During free play the child holds a spade and manipulates the sand. The child looks away and he/she seems not to actively participate in the activity. (Code as *AN*)

### Passive Engagement

The child interacts with the environment without manipulation or vocalisation.

#### *Examples of Passive Engagement*

- (a) The child looks at a teacher or the book during story time.
- (b) The child looks at a friend who is eating his meal during mealtime.
- (c) The child watches other children in the group who are actively engaged.

#### *Nonexamples of Passive Engagement*

- (a) The child looks at an assistant teacher who is helping the child to sit, but the child does not look at a teacher who is telling a story to the group (Code as *PN*).
- (b) During story time the child looks at a friend who is looking at the teacher or the book (Code as *PN*).

### Active Nonengagement

The child interacts with the environment in an inappropriate manner by manipulation, movement and/or vocalisation.

#### *Examples of Active Nonengagement*

- (a) The child wanders around or talks with a friend during story time.
- (b) The child hits a peer during free play (this is an example of *Active Nonengagement*)

with aggressive behaviour, therefore, it requires to circle the 'AN' on a sheet).

#### *Nonexamples of Active Nonengagement*

- (a) The child looks at the teacher or the book when the teacher is reading a story during group time. The child also manipulates his/her shoelace, but his/her eyes are on the teacher or the book (Code as *PE* -- 'Engagement over Nonengagement' rule).
- (b) The child taps a spoon while he/she is eating lunch (Code as *AE* -- 'Engagement over Nonengagement' rule).

#### Passive Nonengagement

The child does not interact with the environment and does not do what is expected of him/her during the activity.

#### *Examples of Passive Nonengagement*

- (a) The child looks at a picture on the wall during story time.
- (b) The child sits in the sandpit during free play, but does not pick up any toys or sand, and does not interact with other children.
- (c) The child looks at a peer who is looking at the story book during story reading.

#### *Nonexamples of Passive Nonengagement*

- (a) The child looks at a picture on the wall during free play (Code as *PE*).
- (b) The child sits in the sandpit during free play, does not pick up any toys or sand, but watches other children's play (Code as *PE*).
- (c) The child looks at a peer during story time. He/she also moves his/her hand. (Code as *AN* -- "Active over Passive" rule even though the child seems to be very keen on looking at the peer and seems to move his/her hand nonintentionally.)

#### Physical Prompts

The child is physically facilitated or guided to an expected behaviour.

#### *Examples of Physical Prompts*

- (a) The child is physically assisted by a teacher to point to a picture.
- (b) The child is physically guided to hold a pencil in order to draw a line.

#### *Nonexamples of Physical Prompts*

- (a) The teacher cuts the child's food into small pieces but does not help the child physically to cut.
- (b) The child writes a letter and the teacher helps him/her to write by holding the end of the pencil. The child is not physically touched and the child holds the pencil independently. The teacher assists him/her writing skill but the child is independently engaged in the activity by holding the pencil.

#### Interaction

Communicative exchange including (a) verbal or nonverbal exchange between the child and another individual, (b) attempt to direct communication to another individual, and/or (c) occurrence of joint cooperative activity (adapted from Carter, Kemp, & Iacono, 1995). The interaction must be happening at the moment to be recorded. If the interaction happens before the tone but the interaction does not continue at the tone, choose 'No' for

interaction.

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#### *Examples of Interaction*

- (a) The child is in a sand pit and the teacher sits next to the child. The child shows the scoop to the teacher, and the teacher comments to the child, for instance, “you have a blue spade.”
- (b) When asked to choose food by a teacher during mealtime, the child points or responds orally.
- (c) The child tries to request food. Even if the teacher does not recognise the attempt, this is considered to be an interaction.
- (d) The teacher tells the child to sit. The child does not acknowledge or appear to realise that the teacher speaks to him/her.

#### *Nonexample of Interaction*

- (a) The teacher holds the child’s hand to guide him/her to sit, but the teacher does not say anything to the child or does not give any eye contact or use gesture. The teacher reads a story to a group of children while helping the child to sit. This is considered to be *Physical Prompt* but not *Interaction*.
- (b) The child looks at what a peer is doing. He/she looks at the peer, but there seems to be no communicative exchange such as talking, touching to get attention, or gestures.
- (c) The teacher tells a group of children to sit. The teacher does not specifically speak to the target child. The child follows the teacher’s instruction.

### **3. ADDITIONAL RULES**

- If the target child is moved away by the teacher, code as *PN* with *Physical Prompt* if the child does not move his/her body. Code *AN* with *Physical Prompt* if the child moves his/her body.
- If the target child demonstrates an involuntary behaviour such as yawning, sneezing, or coughing, code as *AN*.

#### Scenario 1:

The child eats/chews a piece of sandwich (*AE*), but has left the table (*AN*). He/she wanders around the room (*AN*) while eating.

Coding suggestion: *AN* as eating while wandering is not appropriate.

#### Scenario 2:

The child eats/chews a piece of sandwich (*AE*), but he/she is reading a book (*AN* for this context) at the same time. The teacher asks to stop reading, but he/she refuses by screaming (*AN*). He/she continues to eat and read.

Coding suggestion: *AN*

#### Scenario 3:

The child with vision impairment sits in a group, where the teacher tells a story. He/she faces the floor, but seems to listen as he/she does not demonstrate any destructive behaviours such as manipulating a shoelace or talking to others.

Coding suggestion: *PE* even though there is no eye contact with material because there is no evidence that he is *Actively Nonengaged*. This takes into consideration the type of disability.

Scenario 4:

The child with vision impairment sits in a group, where the teacher tells a story. He/she faces the floor and manipulates an edge of a mat (*AN*).

Coding suggestion: *AN* as there is evidence that he/she is *Actively Nonengaged*.

Scenario 5:

The child with vision impairment sits in a group, where the teacher reads a story. He/she looks at the book (*PE* based on general rules) while manipulating an edge of a mat (*AN*).

Coding suggestion: *PE* – ‘Engagement over Nonengagement’ rule

Scenario 6:

During music time, a teacher carries the child who cannot walk because of his/her disability. The teacher carries the child while participating with the other children. The child smiles.

Coding suggestion: *PE* with *Physical Prompt*

#### References

- Carter, M., Kemp, C., & Iacono, T. (1995). *The development and evaluation of a collaborative model of support for students with severe language disorder. Final report to the Directorate of Special Education*. Sydney: Macquarie University.
- McWilliam, R. A., & de Kruijff, R. E. L. (1998). *E-Qual III: Children's Engagement Codes*. Chapel Hill, NC: Frank Porter Graham Child Development Center, University of North Carolina at Chapel Hill.

### ICER-R Scoresheet:

The following ICER-R scoresheet was used electronically by the researcher and manually by the independent raters

Session: \_\_\_\_\_  
 Date Scored: \_\_\_\_\_

	Engagement	Interaction Occurrence	Physical Prompts
	AE(1) PE(2) AN(3) PN(4)	Adult (1) Child (2)	Present 1
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59			
60			

Engagement:

Active

0

Passive

0

Non-Engagement:

Active

0

Passive

0

Interaction:

Adult

Child

Physical Prompts

## Appendix C

### General Procedures checklist

*General Procedures:*

	Yes	No	Comments
Therapy room set up with toys in view of the participant	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Participant positioned in prone/ sidelying on scooterboard with straps	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

*Choice making: provide a tally each time procedures are correctly(white)/ incorrectly(grey) followed at each stage of choosing*

*A response from the participant can be verbal, eye gaze, or in the form of a gesture.*

<b>A: The participant is given a choice of items to play with.</b> (Begin at 1)	1. The therapist places three boxes within reach and in front of the participant and says " Ufuna ukudlala..(names item)" As each box is placed. (if participant responds go to B below – if participant provides a clear positive response prior to all boxes being offered proceed immediately, if no response go to 2)	2. If no response to 1. The therapist says takes an item out of each box, shows it to the participant and says "Sine....(name of item), does this for each item one at a time. (if participant responds go to B below, if no response go to 3)	3. If no response to 2: The therapist performs an action including sound effects, with each of the toys and leaves the toy in front of the box within reach of the participant. (if participant responds go to B below, if no response go to 4)	4. If no response to 3: The therapist states "Awushongo ukuthi ufunani, awuthi ngikukhethela sidlale kancane uzobuye usho ukuthi ufunani futhi."
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<b>B: The participant makes a choice.</b> (Select either 1 or 2)	1. The therapist acknowledges the participant's choice through describing how the choice was made. E.g "Ngiyak'bona ubuka/khomba... Ufuna ukudlala ngako." All other items are removed.	2. If the participant does not select one of the toys in front of them, but provides a response suggesting that they might like an alternative toy from the shelf, then the therapist says "Awuthandi lamathoyisi kodwa ngiyakubona ubuka lezikhafhini. Aw'thi sibuke ukuthi kunani phakathi" The boxes in front of the participant are put away and the other three games placed in front of the participant and a choice of these offered. (Go back to A)		
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

*Play: Provide a ✓ each time the procedures are correctly followed and a ✗ when not at each stage of play*

<p><b>C: Play</b> (Begin at 1, if no response move to 2 etc. when the participant responds go to 4 or E)</p>	<p>1. The therapist ensures that the toys are within reach of the participant, watches the participant and describes what they are doing.</p>	<p>2. If no response to the toys, the therapist instructs the participant on what is required and demonstrates. E.g. push the car, crash the skittles.</p>	<p>3. If no response the participant is engaged in hand over hand facilitation of play with the item.</p>	<p>4. If the participant does respond in 2 or 3 but is unsuccessful in playing then facilitation is provided in order for success to be achieved.</p>
<p><b>D: On-going play</b> (Begin at 1, complete until E is begun by the therapist)</p>	<p>1. The therapist continues play with the participant following the participant's lead, describing play as it progresses.</p>	<p>2. The therapist provides verbal prompts for play to continue.</p>	<p>3. If the participant is unable to play independently hand over hand facilitation is provided.</p>	
<p><b>E: Concluding play</b> (Begin at 1)</p>	<p>1. After 10 minutes of play, (or sooner if a response from the participant suggests that they may be finished). The therapist says "Usoqedile ukudlala noma usafuna ukudlala futhi?" (finished: go to A, more go to 3).</p>	<p>2. If no response from the participant then the therapist packs the game into its box and places all three boxes for the session in front of the participant (revert to A).</p>	<p>3. If the participant clearly indicates they would like to continue playing (through holding onto objects, crying, vocalising). The therapist says " Oh, usafuna ukudlala futhi asidlale ke " (go to D).If the participant clearly indicates they are finished, the toys are packed away and a choice is given (go to A).</p>	<p>4. If the participant responds but it is not possible to ascertain if this is an affirmative or negative response then the therapist says "Ngiyakubona uyakhuluma kodwa angizwa kahle mine, awiphinde ungikhombise lukho okufunayo. " (revert to A)</p>
<p><b>F: Crying participant</b> (Begin at 1)</p>	<p>1. The therapist checks that the participant is not hurt: fingers not trapped, straps not catching and repositions the participant if required.</p>	<p>2. The therapist holds the participant and calms them by singing and/ or rocking</p>	<p>3. A participant who remains inconsolable is handed to their caregiver for calming. Once calm play is re-started. If required the caregivers are included in the session.</p>	<p>4. On return to play the participant is slowly re-introduced to the situation. If required different positioning is used to engage them in play, then slowly re-positioned in prone.</p>

## Appendix D

### Prompt hierarchy checklist

*Instructions:*

1. Provide a ✓ for each step correctly completed and a ✗ if it is incorrect. Checks are provided for both application and sequencing.
2. Multiple checks and crosses may be applied if prompting is repeated in order for movements to be repeated.
3. Begin a new line when a new goal is set (e.g. target has been reached and the game is restarted).

*Requirements for correct completion of a step:*

- **Goal identification:** The clear identification of the item/ person which is to be reached by the movement using the verbal script.
- **Target identification:** The clear identification of the body parts to be used in the movement verbally using the verbal script.
- **Target identified by touch and then facilitated with backward chaining:** The target is given touch/ sensory input and then if required backward chaining provided for the movement to be completed. The sequence of touch then chaining needs to be correctly applied (Backward chaining: the provision of facilitation for the first part of the movement with the participant being required to complete the final step/s themselves).
- **Verbal Feedback:** feedback from the prompt script, provided timeously and specifically

*Verbal script for prompting English and Zulu:*

Verbal Prompts:

English :	Zulu:	English:	Zulu:	English	Zulu:
Put it here.	Beka lana.	Push on your hands.	Fusha ngezandla.	Let's go down..	Asehle.
Push.	Fusha.	Use your legs.	Enza ngenlenze.	Come here.	Woza lana.
Push a little bit more.	Fusha futhi kancane.	Push on your hands.	Fusha ngezandla.	There's still one left.	Kukhona okusele
Let's do it again.	As'phinde senze futhi.	Pop the bubbles.	Bhamisa amagwebu	Can you get it?	Awuzame ukuwisa futhi
Turn around.	Jika.	Push on your feet.	Fusha nge'yawo.	It's gone!	Akusekho!
Catch it.	Bamba.	Push it, it will play a song.	Cindezela, lizocula	Use your hands.	Enza ngezandla.
Crash down the skittles.	Phihli wisa ophini.				

Verbal feedback:

English :	Zulu:	English:	Zulu:	English	Zulu:
Pop pop pop.	Bha bha bha.	Well done!	Wenza kahle.	Your legs are very strong.	Inamandla emlenze yakho.
Crash.	Phihli.	You are a star!	Uyayenza lento yakho!	You're going.	Uyahamba manje.
You're using your hands and your legs!	Usebenzisa konke! Izandla nemlenze.	Yay	Yay!	You're very fast.	Wu! Uyasheshisa eh?
You're a bit tired today.	Ukhathela namuhla.	Look at you driving your car	Ish, awubheke ushayela imoto yakho!	Today we're going slowly.	Sizihambela kancane namuhla.
This is a strong hand.	Sinamandla lesandla.	You're turning and turning.	Uyajika jika.		

*Prompt Hierarchy Checklist*

	Goal identified (goal to be achieved)	Target Identified verbally (body part)	Target Identified by touch and then facilitated with backward chaining.	Verbal feedback
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## Appendix E

### Original participant selection criteria

<b>Criteria:</b>	<b>Justification:</b>	<b>Method for Measurement:</b>
Significant mobility impairment:	A significant mobility impairment is one in which a child has limited control or movement in their extremities, resulting in an inability to move between points independently. A child with significant mobility impairment also finds the transitioning between positions challenging and may need additional support for stationary tasks such as sitting or standing (Üstün, Kostanjsek, Chatterji, & Rehm, 2010)	A classification of level IV or higher on the Gross Motor Function Classification System (GMFCS) as determined by parental response using the GMFCS family report questionnaire and confirmed by the child's therapists. See section 3.5.2.2.1 and appendix J.
Participants will be between the ages of 2 years 0 months and 6 years 11 months of age.	The minimum age is determined by the minimum age for classification on the GMFCS. The maximum age is determined as this is an age at which children should be starting school and upright mobility becomes a requirement.	Caregiver report completed on biographical questionnaire. See appendix G.
Participants with English as their first language will be selected for this study.	As the study was conducted in English. Participants were required to have English as their home language in order to ensure that language compatibility did not impact on the effectiveness of intervention.	Caregiver report, completed on biographical questionnaire. See appendix G.
No peripheral sensory impairment:	Participants with diagnosed peripheral sensory impairment will be excluded from the study. Sensory impairment can result in additional developmental challenges due to the manner in which they interrupt a child's ability to perceive the world around them. E.g. blindness: a child will not automatically seek out a toy at a distance, rather they need to be told and shown where it is before this can occur.	Caregiver report to be substantiated by the professionals working with the child. See appendix G.
Little or no functional speech (LNFS)	Children with significant mobility impairment are at risk of having LNFS at this age. An effective intervention programme needs to target a specific group of children. For the purposes of this research study the target group of children with LNFS has been identified as the target. Children who have little or no functional speech are those who produce no more than 15 consistently intelligible words (Alant, 1999).	Caregiver report, consensus among the professionals. See section 3.5.2.2.2 and appendix G.

Biographical questionnaire in English and isiZulu

*Biographical Information:*

Date of assessment: \_\_\_\_\_ / \_\_\_\_\_ /20\_\_\_\_\_

Surname: \_\_\_\_\_ First Name: \_\_\_\_\_

Date of Birth: \_\_\_\_\_ Chronological Age: \_\_\_\_\_

Sex: Male  Female

Mother's Name: \_\_\_\_\_ tel: \_\_\_\_\_

Father's Name: \_\_\_\_\_ tel: \_\_\_\_\_

Primary Caregiver: \_\_\_\_\_

Diagnosis: \_\_\_\_\_

\_\_\_\_\_

Medication currently taken: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Description of home: House  Flat  Temporary Structure

Type of flooring in home: Tiles  Carpets  Wooden floors  Concrete  Other

Address: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Therapists Seen and Contact details:

Physiotherapist: \_\_\_\_\_ tel: \_\_\_\_\_

Occupational Therapist: \_\_\_\_\_ tel: \_\_\_\_\_

Speech therapist: \_\_\_\_\_ tel: \_\_\_\_\_

Name of Doctor: \_\_\_\_\_ tel: \_\_\_\_\_

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\_\_\_\_\_

Description of Child's Current Abilities: \_\_\_\_\_

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How does your child communicate the following?

Hunger: \_\_\_\_\_

Thirst: \_\_\_\_\_

Discomfort: \_\_\_\_\_

Pain: \_\_\_\_\_

Enjoyment: \_\_\_\_\_

Interest: \_\_\_\_\_

What does your child do when he is very excited? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

What does your child do when he is bored? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

What do you do to encourage your child? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Do you feel your child has any difficulties with hearing and/or seeing? Please describe \_\_\_\_\_

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Do you use any items at home to assist you and your child in activities? These include special chairs for sitting, spoons for feeding, splints to help your child hold things, please describe them \_\_\_\_\_

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Mother's highest educational level achieved: \_\_\_\_\_

Mother's occupation: \_\_\_\_\_

Mother's age at birth: \_\_\_\_\_

Father's highest educational level achieved: \_\_\_\_\_

Father's occupation: \_\_\_\_\_

Father's age at birth: \_\_\_\_\_

Usuku lokuhlolwa: \_\_\_\_\_ / \_\_\_\_\_ /20 \_\_\_\_\_

Isibongo: \_\_\_\_\_ Igama: \_\_\_\_\_

Usuku lokuzalwa: \_\_\_\_\_ Iminyaka ozoba nayo: \_\_\_\_\_

Ubulili: Owesilisa  Owesifazane

Igama likamama: \_\_\_\_\_ Ucingo: \_\_\_\_\_

Igama likababa: \_\_\_\_\_ Ucingo: \_\_\_\_\_

Umnakekeli wokuqala: \_\_\_\_\_

Isifo esitholakele: \_\_\_\_\_

Imishanguzo oyisebenzisa njengamanje: \_\_\_\_\_

Uhlobo lwekhaya: Indlu  Iflethi  Isakhiwo sesikhashana

Uhlobo lwephansi lwendlu: Ama-tiles  Umata  Ipulangwe  Usemende  Okunye

Ikheli: \_\_\_\_\_

Igama likaDokotela omBonile nemiNiningwane yokuXhumana yaKhe:

Udokotela olulamisa amalungu omzimba \_\_\_\_\_ Ucingo: \_\_\_\_\_

USonhlalakahle waseMsebenzini \_\_\_\_\_ Ucingo: \_\_\_\_\_

UDokotela oweLapha iziNkinga zokuKhuluma \_\_\_\_\_ Ucingo: \_\_\_\_\_

Igama likadokotela: \_\_\_\_\_ Ucingo \_\_\_\_\_



Ngabe ubona sengathi umntwana wakho inenkinga yokuzwa kanye/noma yokubona? Sicela uchaze \_\_\_\_\_

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Ngabe kukhona okusebenzisayo ekhaya ukuze uzilekelele noma kulekelele umntwana wakho ekwenzeni okuthile? Lokhu kubandakanya izihlalo ezikhethekile zokuhlala, izipuni zokufunza, izinto zokusiza umntwana wakho ukuthi ibambe izinto, sicela uzichaze \_\_\_\_\_

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Izinga lokufunda eliphezulu likamama: \_\_\_\_\_

Umsebenzi kamama: \_\_\_\_\_

Iminyaka kamama ngesikhathi kuzalwa umntwana: \_\_\_\_\_

Izinga lemfundo eliphezulu likababa: \_\_\_\_\_

Umsebenzi kababa: \_\_\_\_\_

Iminyaka kababa ngesikhathi kuzalwa umntwana: \_\_\_\_\_

## Appendix G

### Information Letter on the study in English and isiZulu



UNIVERSITEIT VAN PRETORIA  
UNIVERSITY OF PRETORIA  
YUNIBESITHI YA PRETORIA  
Faculty of Humanities

52 Key Ridge  
365 Peter Mokaba Rd  
Morningside  
Durban  
4001

#### **A study on the impact of a non-powered, self-initiated mobility programme on the engagement of young children with significant mobility impairment**

For children who have challenges with mobility, it has been seen that their development as a whole can be affected. Not only do they have difficulty in to movement, but their play, development and learning are all impacted.

Studies have been conducted where children have been provided with mobility through the use of powered wheelchairs. In these studies positive developments have been noted in the children's play, communication and independence. In South Africa however, powered mobility is out of reach of most children with disabilities. This study thus aims to assess whether or not a non-powered mobility device can provide benefits for children with significant mobility impairment.

The participation of your child in this study will provide information on the process of introducing a non-powered mobility device to a child with mobility impairment. Through this process we will be able to determine if this is a viable option for children in South Africa.

To enable your participation in this study, you and your child will be requested to attend one pre-assessment session with the researcher. These will ensure that your child is a candidate for the research. Should your child not be a candidate you will be provided with a full written report on their development.

Centre for Augmentative and Alternative Communication (CAAC)  
Sentrum vir Aanvullende en Alternatiewe Kommunikasie (SAAK)  
Communication Pathology Building  
University of Pretoria, Lynnwood Road  
PRETORIA, 0002  
Republic of South Africa

Fax/Faks: +27 86 510 0841  
Tel: +27 12 420 2001

[juan.bornman@up.ac.za](mailto:juan.bornman@up.ac.za)  
[www.caac.up.ac.za](http://www.caac.up.ac.za)

Should your child be identified as a candidate for the study you will be requested to set up dates for the above-mentioned. The study will be conducted over a period of 7 weeks. This will begin with daily sessions for 3-6 days at the start of the study and include a 2 week block where your child is seen daily for 4 days of each week. After the starting week, if your child is not involved in the block of intervention they will be seen once in the week. This is a total of 15 sessions. The intervention will be conducted at 291 Underwood Rd, Sarnia, Pinetown. Each session will be 40 minutes in length.

The initial stage of intervention will focus on your child's play in the therapy setting. For this period your child will play with the researcher during each session. The second stage of intervention (during the 2 week block) focuses on direct mobility training using a non-powered mobility device, which will be implemented using play. Following each session you will be provided with verbal feedback on the progress of your child in their use of the mobility device. The mobility device will be yours to take home at the end of the programme. A full report including pre-assessment and intervention results will be provided to you within 2 weeks of the completion of the programme. All sessions will be video recorded.

When learning new skills it is normal for your child to feel insecure. You will be present in the therapy room throughout all sessions, and should your child become upset, the researcher will provide you with an opportunity to comfort them. She will then request your permission before continuing the intervention. Should you decide that your child is too upset to continue you may end the session.

Confidentiality in the research process is guaranteed. Should you agree for your child to be a participant in the process, kindly deliver your informed consent form to the researcher. The researcher will then contact you to confirm your attendance at the clinic on your selected date. Please keep this information pamphlet for your own use.

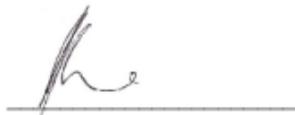
You may at any given time throughout this study decide to withdraw. Should you decide to withdraw, your decision to do so will in no way penalise you, nor the services that are offered to your child. The mobility device supplied will remain yours.

The research results will be made available upon request following the completion of the project. The research data will be stored as hard copy in the Centre for AAC, at the University of Pretoria for 15 years.

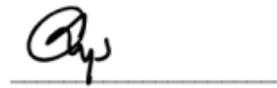
I do understand that you have a busy schedule. It would, however, be of great value if you should agree to participate in this study, as both your and your child's input is highly valued. Should you require any further information, you are welcome to contact me at 082 614 7593 or [knourse@mweb.co.za](mailto:knourse@mweb.co.za).

Thank you in advance for your time and co-operation!

Yours sincerely,



Kirsty Nourse  
Researcher



K Uys  
Supervisor



UNIVERSITEIT VAN PRETORIA  
UNIVERSITY OF PRETORIA  
YUNIBESITHI YA PRETORIA

Faculty of Humanities

**52 Key Ridge  
365 Peter Mokaba Rd  
Morningside  
Durban  
4001**

**Umbuzo nesfundo (i-research) ngomehluko odalwa ukunikezwa isikhathi sokuzihamba hambela ngenqola engasebenzisigesi kulabo bantwana abasebancane abangakwazi ukuzihamba hambela.**

Kulabo bantwana abahlulekayo ukuzihamba hambela, sekubonakele ukuthi ukukhula kwabo konke kuyathinteka. Akusiko ukuhamba hamba kuphela okuthintekayo kodwa futhi ukudlala kwabo, ukukhula nokufunda nje konke kuyathinteka.

Sekuke kwenziwa imibuzo nezifundo lapho abantwana banikezwa indlela yokuzihamba hambela ngokuthi basebenzise izinqola zikagesi. Kwabonakala ngalabo bantwana ukuthi lokhu kudala ukuthi kube khona umehluko ngendlela abadlala ngayo, ngendlela abaxhumana ngayo nangendlela abafunda ukuzenzela izinto. Kodwa ke, lapha eSouth Africa, lezinqola zogesi azitholakali kalula ukuthi izingane zethu zingazithola. Ngakho ke, lombuzo nesfundo ufisa ukuthola ukuthi kungenzeka yini ukuthi inqola engawusebenzisi ugesi ingawenza yini umehluko kulabo bantwana abahlulekayo ukuzihamba hambela.

Ukungenela kwakho nomtwana wakho kulombuzo nesfundo kuzosiza ukuthi sithole impendulo kulombuzo ososhiwo. Futhi sithole ukuthi kungenziwa ngayiphi indlela ukufundisa umtwana.

Centre for Augmentative and Alternative Communication (CAAC)  
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Fax/Faks: +27 86 510 0841  
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[juan.bornman@up.ac.za](mailto:juan.bornman@up.ac.za)  
[www.caac.up.ac.za](http://www.caac.up.ac.za)

ukusebenzisa lenhlobo yenqola engasebenzisi gesi. Lokhu kuzoveza ukuthi lendlela yokuzihamba hambela ingaba yinto engabasiza yini nabanye abantwana lapha eSouth Africa.

Ukuze siqale, wena nomtwana wakho nizocelwa ukuthi nifike kanye lapho nizobonana nalona owenza i-research, okunguyena obuza lombuzo osuchaziwe. Ngalesisikhathi ke, uzobe ebheka ukuthi umtwana wakho angangena yini kulomkhakha awubhekile. Uma kwenzeka ukuthi umtwana wakho engangeni, uzonikezwa incwadi echaza kabanzi ngokwenziwe nokuthi umtwana wakho ubonakele ekhula kanjani (i-report).

Uma umtwana wakho ebonakala ukuthi uyangena, uzocelwa ukuthi uhlele izinsuku ongahle ufike ngazo ukuze kuqhutshekwe. Izikhathi zokusebenzisana nabazali nabantwana sizothatha amasonto ayi-7. Lokhu kuzoqale kube iviki noma izinsuku 3 kuye ku 6, lapho uzobe ufika khona njalo. Emva kwalokho nizofika kanye ngeviki kodwa futhi kukhona lapho kuzophela futhi amasonto amabili lapho nizobe nifika njalo futhi. Sezizonke izikhathi zokufika zibalwa kuma-15 izikhathi. Lokhu kozokwenzelwa eKhethiwe Project, emaromeni eMarianhill. Kuzothatha imizuzu engu-40 njalo uma nifikile.

Ngesikhathi kusaqalwa, kuzobe kubhekwa ukuthi umtwana wakho udlala kanjani. Uzobe edlala nalo obuzayo nofundayo (lo owenza iresearch) – leli yiviki lokuqala. Emva kwalokho uma umtwana esefika njalo futhi (lokhu okwamaviki amabili), kuzobe kubhekwa manje ukusebenza kwalenqola ngenkathi kudlalwa. Njalo umangabe sesiphelile isikhathi somtwana uzolithola ithuba lokubuzwa nokuzwa ukuthi umtwana ubonakele enza kanjani ngalelo langa. Uma sekuphelile konke, lenqola izoba ngeyakho ukuthi ugoduke nayo. Kungakapheli amasonto amabili kuphelile, uzothola incwadi (report) echaza ngokugcwele ngakho konke okwenziwe nomtwana wakho nokuthi ubonakele enjani. Njalo uma nifikile kuyobe kuqoshwa ngama video camera.

Ingane uma ifunda izinto ezintsha kuyenzeka izithole isingabaza noma yesaba. Uyacelwa ukuthi ube khona ngaso sonke isikhathi kusasetshenzwa nomtwana wakho. Uma kwenzeka umtwana ebonakala ukuthi useyakhala noma ukhathazekile, uyocelwa ukuthi umduduze.

Kuyosho wena uma usubona ukuthi sekungaqhutshekwa futhi uma ubona sengathi umtwana

Izindaba zakho neminingwane yakho izophathwa njengemfihlo ngaso sonke isikathi. Uma uvuma ukungenela nomtwana wakho, ngiyacela ukuthi ungibhalele ukuthi uyavuma kuleliphepha onikezwe lona. Lona okunguyena obuzayo nofundayo uzohlela izinsuku akuthinte asho ukuthi ucela ukuthi nifike nini. Uyacelwa ukuthi uligcine leliphepha ulisebenzise ngendlela ozobona ngayo.

Noma usungelelile, ukhululekile ukushiya noma ngasiphi isikhathi. Uma ukhetha ukushiya, kuyoba isinqumo sakho akekho oyokusola, futhi asikho isijeziso. Inqola leyo oyobe uyitholile kuyobe kusengeyakho futhi.

Uma isibhaliwe yonke imiphumelo yalombuzo nesifundo ungayithola umangabe ufisa. Iminingwane nakho konke okuqoqiwe okuyinxenye yalombuzo nesifundo kuyigcinwa kwi-Centre for AAC enyuvesi yasepitoli okuyilapho afunda khona lo obuzayo.

Ngiyazi ukuthi ungumuntu onezinto eziningi okumele azenze. Yize kunjalo, ngingabonga kakhulu uma ungavuma ukungenela nomtwana wakho kulombuzo nesifundo. Sikubhekile ukungenela kwakho nolwazi oluzovela ngani luyigugu kuthina.

Ngiyabonga kakhulu

Yimina



Kirsty Nourse  
Researcher (okunguyena obuzayo nofundayo)



Shakila Dada  
Supervisor (umhloli)

Appendix H  
Approval from research site



[Redacted]  
[Redacted]  
[Redacted]

To: Kirsty Bastable

Re: Conducting a research study at [Redacted] Centre for Children with Disabilities

Thank you for the information you provided us regarding your research study on the role of mobility in the engagement of young children with severe disabilities.

We welcome your use of our facilities for the purpose of your study and are happy to provide you with access to the caregivers of possible candidates in order for them to be able to select whether or not they would like to be a part of the study.

We feel sure that the arrangement will be mutually beneficial and look forward to the opportunity

Yours Sincerely

[Redacted]

(Manager/Physiotherapist)

## Appendix I

### Caregiver consent form English and Zulu

*Please complete this form and return it, to the researcher or deliver it by hand to your therapist.*

Office use		
Participant Nr		

#### Parental Informed Consent: Consent Reply Slip

**Name of Participant:** \_\_\_\_\_

**Name of Parent:** \_\_\_\_\_

**Date:** \_\_\_\_\_

**Project title:**

A study on the impact of a non-powered, self-initiated mobility programme, on the participation of young children with significant mobility impairment.

**Researcher:** Kirsty Nourse  
Doctoral Student  
University of Pretoria

**Supervisor:** Prof. K. Uys

-----  
I understand my rights as well as my child's rights as a participant. I understand the scope of this study and the way in which it will be conducted. I understand that the sessions will be video-taped for data collection purposes and that all information used and obtained in this study will be treated as confidential. I hereby:

- voluntarily declare my consent for my child to participate in this study OR
- declare that my child may not participate in this study.
- I provide consent for the video and audio recording of all sessions.

\_\_\_\_\_  
Parent of Participant



Kirsty Nourse  
Researcher

\_\_\_\_\_  
Date



K. Uys  
Supervisor

- I would like to receive feedback about the results of this study.

*Ngicela uligwalise lelifomu ulibuyisele kimi noma unikeze i-therapist yakho esandleni.*

*Office use*  
*Participant Nr*

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Slip iFomu lokuqiseleka ukuthi emva kokuchazelwa ngayo uyavuma ukungenela i-research.

Igama longenelayo: \_\_\_\_\_

Igama lomzali: \_\_\_\_\_

Usuku: \_\_\_\_\_

**Isihloko somsebenzi Project title:**

Ngomehluko odalwa ukunikezwa isikhathi sokuzihamba hambela ngenqola engasebenzisigesi kulabo bantwana abasebancane abangakwazi ukuzihamba hambela

**Owenza umsebenzi:** Kirsty Nourse  
Doctoral Student  
University of Pretoria

**Ombhekile** : Dr. S. Dada

-----  
Ngiyawazi amalungelo ami nawomtanami njengoba sizongenela. Ngiyayiqonda le-research nokuthi izokwenziwa kanjani. Ngiyazi futhi ukuthi ukuze kubhekwe kahle imphumelo yohlelo lolu kuzoqoshwa ngenkathi kusetshenzwa ngomtwana wami. Ngiyazi futhi ukuthi konke okuvelayo ngenkathi kuhlolwa kuzogcinwa njengemfihlo. Ngalokho ke ngithi:

- Ngaphandle kokuphoqwa ngiyavuma ukuthi ingane yami ingenele kule-research.
- Ngaphandle kokuphoqwa, ngithi ingane yami mayingangenelo kuloluhlelo lwe-research.
- Ngiyavuma ukuthi umsebenzi omaqondana nengane yami uqoshwe ngendlela echaziwe.

\_\_\_\_\_  
Umzali womtwana ongenelayo

\_\_\_\_\_  
Usuku

\_\_\_\_\_  
Kirsty Nourse  
Owenza umsebenzi

\_\_\_\_\_  
S. Dada  
Ombhekile

- Ngiyafisa ukuzwa ukuthi kubhekwe kwatholakalani ngenkathi kuhlolwa le-research.

Appendix J

Ethical Clearance University of Pretoria



UNIVERSITY OF PRETORIA  
YUNIBESITHI YA PRETORIA

Faculty of Humanities  
Research Ethics Committee

30 May 2011

Dear Prof Uys

**Project:** The effect of non-powered, self-initiated mobility on the participation of young children with significant mobility impairment  
**Researcher:** KG Nourse  
**Supervisor:** Prof CJE Uys  
**Department:** Centre for Augmentative and Alternative Communication  
**Reference number:** 22273728

I am pleased to be able to tell you that the above application was **approved (with comment)** by the **Postgraduate Committee** on 10 May 2011 and approved by the **Research Ethics Committee** on 26 May 2011. Data collection may therefore commence.

Please note that this approval is based on the assumption that the research will be carried out along the lines laid out in the proposal. Should the actual research depart significantly from the proposed research, it will be necessary to apply for a new research approval and ethical clearance.

The Committee requests you to convey this approval to the researcher.

We wish you success with the project.

Sincerely

**Prof John Sharp**  
**Chair: Postgraduate Committee & Research Ethics Committee**  
Faculty of Humanities  
UNIVERSITY OF PRETORIA  
e-mail: john.sharp@up.ac.za

Appendix K  
Registration of Title



UNIVERSITEIT VAN PRETORIA  
UNIVERSITY OF PRETORIA  
YUNIBESITHI YA PRETORIA  
Faculty of Humanities

Our Ref: 22273728

5 August 2014

Mrs KG Bastable  
PO Box 52116  
SAXONWOLD  
2132

Dear Mrs Bastable

**TITLE REGISTRATION : FIELD OF STUDY - PHD AUGMENTATIVE AND ALTERNATIVE COMMUNICATION**

I have pleasure in informing you that the following has been approved:

**TITLE:** The effect of non-powered, self-initiated mobility on the engagement of young children with significant mobility impairment

**SUPERVISOR:** Dr S Dada

**CO-SUPERVISOR:** Prof CJE Uys

**PLEASE TAKE NOTE OF THE FOLLOWING INFORMATION AS WELL AS THE ATTACHED REQUIREMENTS.**

1. **PERIOD:**
  - (a) You must be enrolled as a student for at least one academic year before submission of your thesis.
  - (b) Your enrolment as a student must be renewed annually before 31 March, until you have complied with all the requirements for the degree. You will only be liable to have supervision if you provide a proof of registration to your supervisor.
2. **NOTIFICATION BEFORE SUBMISSION:**

You are required to notify me at least three months in advance of your intention to submit your thesis for examination.
3. **APPROVAL FOR SUBMISSION:**

On completion of your thesis enough copies for each examiner as well as the prescribed examination enrolment form which includes a statement by your promoter that he/she approves of the submission of your thesis, as well as a statement signed by you, must be submitted to Student Administration.
4. **DATE OF EXAMINATION:**

If your doctoral examination is to take place after the submission of your thesis, please inform me of the date of the examination.

Yours sincerely

for **DEAN: FACULTY OF HUMANITIES**

Information Technology Building 2-9  
Humanities Student Administration  
University of Pretoria  
Private Bag X20, Hatfield 0028  
Republic of South Africa

Tel: +27 (0)12 4202959  
Fax: +27 (0)12 4202698

Email: [jana.bezuidenhout@up.ac.za](mailto:jana.bezuidenhout@up.ac.za)  
Website: [www.up.ac.za](http://www.up.ac.za)

## Appendix L

### Declaration of Originality:

#### UNIVERSITY OF PRETORIA

#### DECLARATION OF ORIGINALITY

**This document must be signed and submitted with every essay, report, project, assignment, mini-dissertation, dissertation and/or thesis**

Full names of student: **Kirsty Gillian Bastable**

Student **number: 22273728**

#### Declaration

1. I understand what plagiarism is and am aware of the University's policy in this regard.
2. I declare that this **thesis** is my own original work. Where other people's work has been used (either from a printed source, Internet or any other source), this has been properly acknowledged and referenced in accordance with departmental requirements.
3. I have not used work previously produced by another student or any other person to hand in as my own.
4. I have not allowed, and will not allow, anyone to copy my work with the intention of passing it off as his or her own work.

SIGNATURE OF STUDENT:



SIGNATURE OF SUPERVISOR:.....



.....